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1912

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1912.

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THE ROYAL SOCIETY of New South Wales originated in 1821 as the "Philosophical Society of Australasia"; after an interval of inactivity, it was resuscitated in 1850, under the name of the "Australian Philosophical Society," by which title it was known until 1856, when the name was changed to the "Philosophical Society of New South Wales"; in 1866, by the sanction of Her Most Gracious Majesty Queen Victoria, it assumed its present title, and was incorporated by Act of the Parliament of New South Wales in 1881.

TO AUTHORS.

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PUBLICATIONS.

The following publications of the Society, if in print, can be obtained at the Society's House in Elizabeth-street:—

Transactions of the Philosophical Society, N.S.W., 1862-5, pp. 374, out of print.

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Royal Society of New South Wales.

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I bequeath the sum of £   to the ROYAL SOCIETY OF NEW SOUTH WALES, Incorporated by Act of the Parliament of New South Wales in 1881, and I declare that the receipt of the Treasurer for the time being of the said Corporation shall be an effectual discharge for the said Bequest, which I direct to be paid within   calendar months after my decease, without any reduction whatsoever, whether on account of Legacy Duty thereon or otherwise, out of such part of my estate as may be lawfully applied for that purpose.

[*Those persons who feel disposed to benefit the Royal Society of New South Wales by Legacies, are recommended to instruct their Solicitors to adopt the above Form of Bequest.*]

LIST OF THE MEMBERS

OF THE

Royal Society of New South Wales.

P Members who have contributed papers which have been published in the Society's Transactions or Journal; papers published in the Transactions of the Philosophical Society are also included. The numerals indicate the number of such contributions.

‡ Life Members.

Elected.		
1908		Abbott, George Henry, B.A., M.B., CH.M., Macquarie-street; p.r. 'Cooringa,' 252 Liverpool Road, Summer Hill.
1877	P 5	Abbott, W. E., 'Abbotsford,' Wingen.
1895		Adams, J. H. M., Broughton Cottage, St. James' Rd., Waverley.
1904		Adams, William John, M. I. MECH. E, 175 Clarence-street.
1898		Alexander, Frank Lee, c/o Messrs. Goodlet and Smith Ld., Cement Works, Granville.
1905		Anderson, Charles, M.A., D.SC. *Edin.*, Australian Museum, College-street.
1909	P 6	Andrews, E. C., B.A., F.G.S., Geological Surveyor, Department of Mines, Sydney.
1878		Backhouse, His Honour Judge A. P., M.A., 'Melita,' Elizabeth Bay.
1894	P 18	Baker, Richard Thomas, F.L.S., Curator, Technological Museum.
1894		‡Balsille, George, 'Lauderdale,' N.E. Valley, Dunedin, N.Z.
1896		Barff, H. E., M.A., Registrar, The University of Sydney.
1908	P 1	Barling, John, 'St. Adrians,' Raglan-street, Mosman.
1895	P 9	Barraclough, S. Henry, B.E., M.M.E., ASSOC. M. INST. C.E., M. I. MECH. E., Memb. Soc. Promotion Eng. Education; Memb. Internat. Assoc. Testing Materials; Lecturer in Mechanical Engineering in the University of Sydney; p.r. 'Marmion,' Victoria-street, Lewisham.
1906		Basnett, Nathaniel James, Accountant, Punch-st., Mosman.
1894		Baxter, William Howe, Chief Surveyor, Existing Lines Office, Railway Department, Bridge-street.
1877		Belfield, Algernon H., 'Eversleigh,' Dumaresq.
1900		Bender, Ferdinand, Accountant and Auditor, 114 Hunter-st.
1909		Benson, William Noel, B.SC., Emmanuel College, Cambridge, England.
1905		Bignold, Hugh Baron, Barrister-at-Law, Chambers, Wentworth Court, 64 Elizabeth-street.
1905		Blakemore, George Henry, Australian Club, Macquarie-street.
1888		‡Blaxland, Walter, F.R.C.S. *Eng.*, L.R.C.P. *Lond.*, Fremantle, West Australia.
1893		Blomfield, Charles E., B.C.E. *Melb.*, 'Woombi,' Kangaroo Camp, Guyra.

Elected		
1898		Blunno, Michele, Licentiate in Science (Rome), Government Viticultural Expert, Department of Agriculture. Sydney.
1907		Bogenrieder, Charles, Mining and Consulting Engineer, 'Scibile,' Little's Avenue, off Nicholson-street, Balmain.
1879		‡Bond, Albert, 131 Bell's Chambers, Pitt-street.
1907		Boyd, Robert James, M.E., ASSOC. M. INST. C.E., 'Greenstead,' Park Road, Burwood,
1910		Bradley, Clement Henry Burton, M.B., CH.M., D.P.H., Bureau of Microbiology, Macquarie-street.
1876		Brady, Andrew John, L.K. and Q.C P. *Irel.*, L.R.C.S. *Irel.*, 175 Macquarie-street, Sydney.
1891		Brennand, Henry J. W., B.A., M.B., CH.M. *Syd.*, 'The Albany,' Macquarie-st., p.r. 'Wobun,' 310 Miller-st., North Sydney.
1902		Brereton, Victor Le Gay, Solicitor, Royal Chambers, Hunter-street; p.r. 'Osgathorpe,' Gladesville.
1878		‡Brooks, Joseph, F.R A.S., F.R.G.S., 'Hope Bank,' Nelson-street, Woollahra.
1876		Brown, Henry Joseph, Solicitor, Newcastle,
1906		Brown, James B., Resident Master, Technical School, Granville; p.r. 'Kingston,' Merrylands.
1903		Bruck, Ludwig, Medical Publisher, 15 Castlereagh-street.
1898		‡Burfitt, W. Fitzmaurice, B.A., B.SC., M.B., CH.M. *Syd.*, 357 Glebe Road, Glebe Point.
1890		Burne, Alfred, D.D.S., Buckland Chambers, 183 Liverpool-st.
1907		Burrows, Thomas Edward, M. INST. C.E., L.S., Metropolitan Engineer, Public Works Department; p.r. 'Balboa,' Fern-street, Randwick.
1880		Bush, Thomas James, M. INST. C.E., Australian Gas-light Company, 153 Kent-street.
1909		Calvert, Thomas Copley, ASSOC. M. INST. C.E., 'Maybank,' Manly.
1904	P 1	Cambage, Richard Hind, L.S., F.L.S., Chief Mining Surveyor; p.r. Park Road, Burwood. *The President.*
1907		Campbell, Alfred W., M.D., CH.M. *Edin.*, 183 Macquarie-street.
1900		Canty, M., 'Rosemont,' 13 York-street, Wynyard Square.
1876		Cape, Alfred J., M.A. *Syd.*, 'Karoola,' Edgecliffe Rd,, Edgecliffe.
1897	P 4	Cardew, John Haydon, M. INST. C.E., L.S., 75 Pitt-street.
1901		Card, George William, A.R.S.M., F.G.S., Curator and Mineralogist to the Geological Survey, Department of Mines, Sydney,
1891		Carment, David, F.I.A. *Grt. Brit. & Irel.* F.F.A., *Scot.*, Australian Mutual Provident Society, 87 Pitt-st. *Hon. Treasurer.*
1909		Carne, Joseph Edmund, F.G.S., Assistant Government Geologist, Department of Mines, Sydney.
1903		Carslaw, H. S., M.A., D.SC., Professor of Mathematics in the University of Sydney.
1909	P 1	Chapman, H. G., M.D., Assistant Lecturer and Demonstrator in Physiology in the University of Sydney.
1908		Chauleur, Paul, Officier de l'Instruction Publique, Conseiller du Commerce Extérieur de la France; Secrétaire-Trésorier de la Chambre de Commerce française, 2 Bond-st., G.P.O. Box 583, Sydney.
1909	P 10	Cleland, John Burton, M.D., CH.M., Principal Assistant Microbiologist, Bureau of Microbiology, 93 Macquarie-street.

Elected		
1907		Cobham, Allan Blenman, 'Garthowen,' Myahgah Rd., Mosman.
1896	P 2	Cook, W. E., M.C.E. *Melb.*, M. INST. C.E., Water and Sewerage Board, North Sydney.
1904	P 2	Cooksey, Thomas, PH.D., D.SC. *Lond.*, F.I.C., Second Government Analyst; p.r. 'Clissold,' Calypso Avenue, Mosman.
1876		Codrington, John Frederick, M.R.C.S. *Eng.*, L R.C.P. *Lond.*, L.R.C.P. *Edin.*, 'Roseneath,' 8 Wallis-street, Woollahra.
1906		Colley, David John K., Superintendent, Royal Mint, Sydney.
1882		Cornwell, Samuel, J.P., Brunswick Road, Tyagarah.
1909	P 1	Cotton, Leo Arthur, B.A., B.SC., Assistant Lecturer and Demonstrator in Geology in the University of Sydney.
1892	P 1	Cowdery, George R., ASSOC. M. INST. C.E., Blaski Buildings, Hunter-st.; p,r. 'Glencoe,' Torrington Road, Strathfield.
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1890		Dare, Henry Harvey, M.E., M. INST. C.E., Public Works Department.
1876	P 3	Darley, Cecil West, M. INST. C.E., Australian Club, Sydney.
1910		Darnell-Smith, George Percy, B.SC., F.I.C., F.C.S., Bureau of Microbiology, Macquarie-street.
1886	P 21	David, T. W. Edgeworth, C.M.G., B.A., D.SC., F.R.S., F.G.S., Professor of Geology and Physical Geography in the University of Sydney. *Vice-President.*
1909		Davidson, George Frederick, 223 Bridge Road, Glebe Point.
1892	P 1	Davis, Joseph, M. INST. C.E., Director-General, Public Works Department, Sydney.
1907		Davys, Hubert John, c/o Messrs. Clutterbuck Bros. & Co., Builders' Exchange, Castlereagh-street; p.r. 'La Bohème,' Marshall-street, Manly.
1885	P 3	Deane, Henry, M.A., M. INST. C.E., F.L.S., F.R. MET. SOC., F.R.H.S., Commercial Bank Chambers, George-street; p.r. 'Blanerne,' Wybalena Road, Hunter's Hill.
1894		Dick, James Adam, B.A. *Syd.*, M.D., C.M., F.R.C.S. *Edin.*, 'Catfoss,' Belmore Road, Randwick.
1875	P 12	Dixon, W. A., F.I.C., F.C.S., 97 Pitt-street.
1880		Dixson, Thomas Storie, M.B., M.S. *Edin.*, 225 Macquarie-street.
1906		Dixson, William, 'Merridong,' Gordon Road, Killara.
1876		Docker, His Honour Judge E. B., M.A., 'Mostyn,' Billyard Avenue, Elizabeth Bay.
1899	P 1	Duckworth, A., F.R.E.S., A.M.P. Society, 87 Pitt-street; p.r. 'Trentham,' Woollahra.
1873	P 2	Du Faur, E., F.R.G.S., 'Flowton,' Turramurra.
1908	P 2	Dun, William S., Palæontologist, Department of Mines.
1908		Esdaile, Edward William, Optician, 54 Hunter-street.
1910		Estens, John Locke, 55 Flinders-street, Sydney.
1879	P 4	Etheridge, Robert, Junr., J.P., Curator, Australian Museum; p.r. 'Inglewood,' Colo Vale, N.S.W.

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1877		‡Fairfax, Edward Ross, *S. M. Herald* Office, Hunter-street.
1896		Fairfax, Geoffrey E., *S. M. Herald* Office, Hunter-street.
1868		Fairfax, Sir James R., Knt., *S. M. Herald* Office, Hunter-st.
1887		Faithfull, R. L., M.D., *New York*, L.R.C.P., L.S.A. *Lond.*, 5 Lyons Terrace.
1902		Faithfull, William Percy, Barrister-at-Law, Australian Club.
1912		Farnsworth, W. J., D.D.S. *Penn.*, Bannerman-st., Neutral Bay.
1910		Farrell, John, Assistant Teacher, Sydney Technical College; p.r. 8 Thompson-street, Darlinghurst.
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1881		Fiaschi, Thos., M.D., M.CH. *Pisa*, 149 Macquarie-street.
1888		Fitzhardinge, His Honour Judge G. H., M.A., 'Red Hill,' Beecroft.
1900		‡Flashman, James Froude, B.A., B.SC., M.D., CH.M., Jersey Road, Burwood.
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1905		Foy, Mark, 'Eumemering,' Bellevue Hill, Woollahra.
1904		Fraser, James, M. INST. C.E., Engineer-in-Chief for Existing Lines, Bridge-street; p.r. 'Arnprior,' Neutral Bay.
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1899		French, J. Russell, General Manager, Bank of New South Wales, George-street.
1881		Furber, T. F., F.R.A.S., Lands Department.
1876		George, W. R., 318 George-street.
1859		Goodlet, J. H., 'Canterbury House,' Ashfield.
1906		Gosche, Vesey Richard, Consul for Nicaragua, 1 Bulletin Place, Pitt-street, City.
1906		Gosche, W. A. Hamilton, Electrical Engineer, 1 Bulletin Place, Pitt-street, City.
1897		Gould, Senator The Hon. Sir Albert John, K.C.M.G., 'Eynesbury,' Edgecliffe.
1907		Green, W. J., Chairman, Hetton Coal Co., Athenæum Club.
1899		Greig-Smith, R., D.SC. *Edin.*, M.SC. *Dun.*, Macleay Bacteriologist, Linnean Society's House, Ithaca Road, Elizabeth Bay.
1912		Grieve, Robert Henry, B.A., 'Langtoft,' Llandaff-st., Waverley.
1912		Griffiths, F. Guy, B.A., M.D., CH.M., 135 Macquarie-st., Sydney.
1899	P 2	Gummow, Frank M., M.C.E., Corner of Bond and Pitt-streets.
1891	P 16	Guthrie, Frederick B., F.I.C., F.C.S., Chemist, Department of Agriculture, 137 George-street, Sydney. *Vice-President.*
1880	P 3	Halligan, Gerald H., F.G.S., 'Riversleigh,' Hunter's Hill.
1912		Hallmann, E. F., B.SC., 65 View-street, Annandale.
1892		Halloran, Henry Ferdinand, L.S., 82 Pitt-street.
1909		Hammond, Walter L., Science Master, Hurlstone Agricultural Continuation School, Hurlstone Avenue, Summer Hill.
1912		Hamilton, A. G., Lecturer on Nature Study, Teachers' College, Blackfriars.
1887	P 8	Hamlet, William M., F.I.C., F.C.S., Member of the Society of Public Analysts; Government Analyst, Health Department, Macquarie-street, North.

Elected		
1905	P 1	Harker, George, D.SC., 35 Boulevarde, Petersham.
1887	P 23	‡Hargrave, Lawrence, Wunulla Road, Woollahra Point.
1884	P 1	Haswell, William Aitcheson, M.A., D.SC., F.R.S., Professor of Zoology and Comparative Anatomy in the University of Sydney; p.r. 'Mimihau,' Woollahra Point.
1900		Hawkins, W. E., Solicitor, 88 Pitt-street.
1891	P 1	Hedley, Charles, F.L.S., Assistant Curator, Australian Museum, Sydney.
1899		Henderson, J., F.R.E.S., Manager, City Bank of Sydney, Pitt-st.
1884	P 1	Henson, Joshua B., ASSOC. M. INST. C.E., Hunter District Water Supply and Sewerage Board, Newcastle.
1905		Hill, John Whitmore, Architect, 'Willamere,' May's Hill, Parramatta.
1876	P 2	Hirst, George D., F.R.A.S., c/o Messrs. Tucker & Co., 215 Clarence-street.
1896		Hinder, Henry Critchley, M.B., CH.M. *Syd.*, 147 Macquarie-st.
1892		Hodgson, Charles George, 157 Macquarie-street,
1901		Holt, Thomas S., 'Amalfia,' Appian Way, Burwood.
1905		Hooper, George, Assistant Superintendent, Sydney Technical College; p.r. 'Banksome,' Henson-street, Summer Hill.
1891	P 2	Houghton, Thos. Harry, M. INST. C.E., M. I. MECH. E., 63 Pitt-st.
1906		Howle, Walter Cresswell, L.S.A. *Lond.*, Bega, N.S.W.
1904		Jaquet, John Blockley, A.R.S.M., F.G.S., Chief Inspector of Mines, Department of Mines.
1904		Jenkins, R. J. H., 'Ettalong,' Roslyn Gardens, Rushcutters' Bay.
1905	P 8	Jensen, Harold Ingemann, D.SC., Government Geologist, Darwin, Northern Territory.
1907		Johnson, T. R., M. INST. C.E., Chief Commissioner of New South Wales Railways, Sydney.
1909	P 13	Johnston, Thomas Harvey, M.A., D.SC., F.L.S., Biology Department, The University, Brisbane.
1902		Jones, Henry L., ASSOC. AM. SOC. C.E., 14 Martin Place.
1867		Jones, Sir P. Sydney, Knt., M.D. *Lond.*, F.R.C.S. *Eng.*, 'Llandilo,' Boulevarde, Strathfield.
911		Julius, George A., B.SC., M.E., Norwich Chambers, Hunter-st.
1907		Kaleski, Robert, Agricultural Expert, Holdsworthy, Liverpool.
1883		Kater, The Hon. H. E., J.P., M.L.C., Australian Club.
]	P 3	Keele, Thomas William, M. INST. C.E., Commissioner, Sydney Harbour Trust, Circular Quay; p.r. Llandaff-st., Waverley,
1887		Kent, Harry C., M.A., F.R.I.B.A., Dibbs' Chambers, Pitt-street.
1901		Kidd, Hector, M. INST. C.E., M. I. MECH. E., 'Craig Lea,' 15 Mansfield-street, Glebe Point.
1896		King, Kelso, 120 Pitt-street.
1878		Knaggs, Samuel T., M.D. *Aberdeen*, F.R.C.S. *Irel.*, 'Wellington,' Bondi Road, Bondi.
1881	P 22	Knibbs, G. H., C.M.G., F.S.S., F.R.A.S., Member Internat. Assoc. Testing Materials; Memb. Brit. Sc. Guild; Commonwealth Statistician, Melbourne.
1877		Knox, Edward W., 'Rona,' Bellevue Hill, Double Bay.

Elected		
1911	P 2	Laseron, Charles Francis, Technological Museum.
1906		Lee, Alfred, 'Glen Roona,' Penkivil-street, Bondi.
1909		Leverrier, Frank, B.A., B.SC., K.C., 182 Phillip-street.
1883		Lingen, J. T., M.A. *Cantab.*, Selborne Chambers, Phillip-street.
1906		Loney, Charles Augustus Luxton, M. AM. SOC. REFR. E., Equitable Building, George-street.
1911		Longmuir, G. F., B.A., Science Master, Technical College, Bathurst.
1912		Lovell, Henry Tasman, M.A., PH.D., 'Tane,' Hodson Avenue, Cremorne.
1884		MacCormick, Alexander, M.D., C.M. *Edin.*, M.R.C.S. *Eng.*, 185 Macquarie-street, North.
1887		MacCulloch, Stanhope H., M.B., CH.M, *Edin.*, 24 College-street.
1878		MacDonald, Ebenezer, J.P., c/o Perpetual Trustee Co, Ld., 2 Spring-street.
1903		McDonald, Robert, J.P., Pastoral Chambers, O'Connell-street; 'Wairoa.' Holt-street, Double Bay,
1891		McDouall, Herbert Chrichton, M.R.C.S. *Eng.*, L.R.C.S. *Lond.*, D.P.H. *Cantab.*, Hospital for the Insane, Gladesville.
1906		McIntosh, Arthur Marshall, Dentist, Hill-street, Roseville.
1891	P 2	McKay, R. T., ASSOC. M. INST. C.E., Geelong Waterworks and Sewerage Trusts Office, Geelong, Victoria.
1893		McKay, William J. Stewart, B.SC., M.B., CH.M., Cambridge-street, Stanmore.
1876		Mackellar, The Hon. Sir Charles Kinnaird, M.L.C.. M.B., C.M. *Glas.*, Equitable Building, George-street.
1904		McKenzie, Robert, Sanitary Inspector, (Water and Sewerage Board), 'Stonehaven Cottage,' Bronte Road, Waverley.
1880	P 9	McKinney, Hugh Giffin, M.E., Roy. Univ. *Irel.*, M. INST. C.E., Australian Club, Macquarie-street.
1912	P 1	MacKinnon, Ewen, B.SC., Assistant Microbiologist, Bureau of Microbiology, Macquarie-street.
1903		McLaughlin, John, Solicitor, Union Bank Chambers, Hunter-st.
1876		MacLaurin, The Hon. Sir Henry Normand, M.L.C., M.A., M.D., L.R.C.S. *Edin.*, LL.D. *St. Andrews*, 155 Macquarie-street.
1901	P 1	McMaster, Colin J., Chief Commissioner of Western Lands; p.r. Wyuna Road, Woollahra Point.
1894		McMillan, Sir William, K.C.M.G., 'Althorne,' 281 Edgecliffe Road, Woollahra.
1899		MacTaggart, J. N. C., M.E. *Syd.*, ASSOC. M. INST. C.E., Water and Sewerage Board District Office, Lyons Road, Drummoyne.
1909		Madsen, John Percival Vissing, D.SC., B.E., P. N. Russell Lecturer in Electrical Engineering in the University of Sydney.
1883	P 22	Maiden, J. Henry, J.P., F.L.S., Hon. Fellow Roy. Soc. S.A.; Hon. Memb. Nat. Hist. Soc., W.A.; Netherlands Soc. for Promotion of Industry; Philadelphia College Pharm.; Southern Californian Academy of Sciences; Pharm. Soc. N.S.W.; Brit. Pharm. Conf.; Corr. Fellow Therapeutical Soc., Lond.; Corr. Memb. Pharm. Soc. Great Britain; Bot. Soc. Edin.; Soc. Nat. de Agricultura (Chile); Soc. d'

Elected		
		Horticulture d' Alger; Union Agricole Calédonienne; Soc. Nat. etc., de Chérbourg; Roy. Soc. Tas.; Roy. Soc. Queensl.; Inst. Nat. Genévois; Hon. Vice-Pres. of the Forestry Society of California; Diplomé of the Société Nationale d'Acclimatation de France; Government Botanist and Director, Botanic Gardens, Sydney. *Hon. Secretary.*
1906		Maitland, Louis Duncan, Dental Surgeon, Tumut.
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1879		Moore, Frederick H., Union Club, Sydney.
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1876		Myles, Charles Henry, 'Dingadee,' Everton Rd., Strathfield.
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1891		‡Noble, Edward George, Public Works Department, Newcastle.
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1896		Plummer, John, 'Northwood,' Lane Cove River; Box 413 G.P.O.
1881		Poate, Frederick, Surveyor-General, Lands Department, Sydney.
1879		Pockley, Thomas F. G., Union Club, Sydney.
1887	P 8	Pollock, J. A., D.SC., Corr. Memb. Roy, Soc. Tasmania; Roy. Soc. Queensland; Professor of Physics in the University of Sydney. *Hon. Secretary.*
1896		Pope, Roland James, B.A., *Syd.*, M.D., C.M., F.R.C.S., *Edin.*, 'Wyoming,' Macquarie-street.
1910		Potts, Henry William, F.L.S., F.C.S., Principal, Hawkesbury Agricultural College, Richmond, N.S.W.
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1890	P 1	Rae, J. L. C., 'Lisgar,' King-street, Newcastle.
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1906		Redman, Frederick G., P. and O. Office, Pitt-street.
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1893		Sinclair, Russell, M. I. MECH. E., Vickery's Chambers, 82 Pitt-st.
1891	P 3	Smail, J. M., M. INST. C.E., Chief Engineer, Metropolitan Board of Water Supply and Sewerage, 341 Pitt-street.
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1893	P 41	Smith, Henry G., F.C.S., Assistant Curator, Technological Museum, Sydney.
1874	P 1	‡Smith, John McGarvie, 89 Denison-street, Woollahra.
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1861	P 19	Tebbutt, John, F.R.A.S., Private Observatory, The Peninsula, Windsor, New South Wales.
1878		Thomas, F. J., Newcastle and Hunter River Steamship Co., 147 Sussex-street.
1879		Thomson, The Hon. Dugald, Carrabella-st., North Sydney.
1885	P 2	Thompson, John Ashburton, M.D. *Brux.*, D.P.H. *Cantab.*, M.R.C.S. *Eng.*, Health Department, Macquarie-street.
1896		Thompson, Major A. J. Onslow, Camden Park, Menangle.

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1892		Thow, William, M. INST. C.E., M. I. MECH. E., 'Inglewood,' Lane Cove Road, Wahroonga.
1894		Tooth, Arthur W., Kent Brewery, 26 George-street, West.
1879		Trebeck, P. C., F. R. MET. SOC., 12 O'Connell-street.
1900		Turner, Basil W., A.R.S.M., F.C.S., Victoria Chambers, 83 Pitt-st.
1883		Vause, Arthur John, M.B., C.M. *Edin.*, 'Bay View House,' Tempe.
1890		Vicars, James, M.E., Memb. Intern. Assoc. Testing Materials; Memb. B. S Guild; Challis House, Martin Place.
1892		Vickery, George B., 78 Pitt-street.
1903	P 2	Vonwiller, Oscar U., B.SC., Assistant Lecturer and Demonstrator in Physics in the University of Sydney.
1907		Waley, F. G., ASSOC. M. INST. C.E., Royal Insurance Building, Pitt-street.
1879		Walker, H. O., Commercial Union Assurance Co., Pitt-street.
1899		‡Walker, Senator The Hon. J. T., F.R.C.I., Fellow of Institute of Bankers *Eng.*, 'Wallaroy,' Edgecliffe Road, Woollahra.
1910		Walker, Charles, Metallurgical Chemist, 80 Bathurst-street, p.r. 'Kuranda,' Waverley-street, Waverley.
1910		Walker, Harold Hutchison, Major St. George's English Rifle Regiment, C.M.F., 'Vermont,' Belmore Road, Randwick.
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1898		Wark, William, ASSOC. M. INST. C.E., 9 Macquarie Place; p.r. Kurrajong Heights.
1883	P 17	Warren, W. H., LL.D., WH. SC., M. INST. C.E., M. AM. SOC. C,E., Member of Council of the International Assoc. for Testing Materials, Professor of Engineering in the University of Sydney.
1876		Watkins, John Leo, B.A. *Cantab.*, M A. *Syd.*, Parliamentary Draftsman, Atorney General's Department, Macquarie-st.
1876		Watson, C. Russell, M.R.C.S. *Eng.*, 'Woodbine,' Erskineville.
1910		Watson, James Frederick, M.B., CH. M., Australian Club, Sydney.
1910		Watt, Francis Langston, F.I.C., A.R.C.S., 10 Northcote Chambers, off 16½ Pitt-street, City.
1911		Watt, R. D., M.A., B.SC., Professor of Agriculture in the University of Sydney.

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1910	P 1	Wearne, Richard Arthur, B.A., Principal, Technical College, Ipswich, Queensland.
1897		Webb, Frederick William, C.M.G., J.P., 'Livadia,' Manly.
1903		Webb, A. C. F., M.I.E.E., Vickery's Chambers, 82 Pitt-street.
1892		Webster, James Philip, ASSOC. M. INST. C.E., L.S., *New Zealand*, Town Hall, Sydney.
1907		Weedon, Stephen Henry, C.E., 'Kurrowah,' Alexandra-street, Hunter's Hill.
1907		Welch, William, F.R.G.S., 'Roto-iti,' Boyle-street, Mosman.
1881		‡Wesley, W. H., London.
1892		White, Harold Pogson, F.C.S., Assistant Assayer and Analyst, Department of Mines; p.r. 'Quantox,' Park Road, Auburn.
1877		‡White, Rev. W. Moore, A.M., LL.D. *Dub.*
1909		White, Charles Josiah, B.SC., Science Lecturer, Sydney Training College; p.r. 'Patea,' Miller Avenue, Ashfield.
1879		‡Whitfeld, Lewis, M.A. *Syd.*, 'Sellinge.' Albert-st., Woollahra.
1907		Wiley, William, 'Kenyon,' Kurraba Point, Neutral Bay.
1876		Williams, Percy Edward, 'St. Vigeans,' Dundas.
1908	P 1	Willis, Charles Savill, M.B., CH.M. *Syd.*, M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, D.P.H., Roy. Coll. P. & S. *Lond.*, Department of Public Health.
1901		Willmot, Thomas, J.P., Toongabbie.
1890		Wilson, James T., M.B., CH.M. *Edin*, F.R.S., Professor of Anatomy in the University of Sydney.
1907		Wilson, W. C., Public Works Department, Sydney.
1891		Wood, Percy Moore, L.R.C.P. *Lond.*, M.R.C.S. *Eng.*, 'Redcliffe,' Liverpool Road, Ashfield.
1909		Woodhouse, William John, M.A., Professor of Greek in the University of Sydney.
1906	P 6	Woolnough, Walter George, D.SC., F.G.S., Professor of Geology in the University of Western Australia, Perth.
1909		Yeomans, Richard John, Solicitor, 14 Castlereagh-street.

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1911		Hemsley, W. Botting, F.R.S., Formerly Keeper of the Herbarium, Royal Gardens, Kew, 24 Southfield Gardens, Strawberry Hill, Middlesex.
1901		Judd, J.W., C.B., LL.D., F.R.S., F.G.S., Formerly Professor of Geology, Royal College of Science, London; 30 Cumberland Road, Kew, England.
1908		Kennedy, Sir Alex. B. W., Kt., LL.D., D. ENG., F.R.S., Emeritus Professor of Engineering in University College, London, 17 Victoria-street, Westminster, London S.W.
1908	P 57	*Liversidge, Archibald, M.A., LL.D., F.R.S., Emeritus Professor of Chemistry in the University of Sydney, 'Fieldhead,' George Road, Coombe Warren, Kingston, Surrey.

Elected		
1912		Martin, C. J., D.SC., F.R.S., Director of the Lister Institute of Preventive Medicine, Chelsea Gardens, Chelsea Bridge Road, London.
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Obituary 1912.

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Vice-President from 1866 *to* 1878.

To be awarded from time to time for meritorious contributions to the Geology, Mineralogy, or Natural History of Australia. The prefix * indicates the decease of the recipient.

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1895 Robert Etheridge, Junr., Curator of the Australian Museum, Sydney

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1901 *Edward John Eyre.

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1903 *Alfred William Howitt, D.SC. F.G.S.

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1882 John Fraser, B.A., West Maitland, for paper on 'The Aborigines of New South Wales.'

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The Society's Bronze Medal and £25.

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1886 S. H. Cox, F.G.S., F.C.S., Sydney for paper on 'The Tin deposits of New South Wales.

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1888 Rev. J. E. Tenison-Woods, F.G.S., F.L.S., Sydney, for paper on 'The Anatomy and Life-history of Mollusca peculiar to Australia.'

1889 Thomas Whitelegge, F.R.M.S., Sydney, for 'List of the Marine and Fresh-water Invertebrate Fauna of Port Jackson and Neighbourhood.

1889 Rev. John Mathew, M.A., Coburg, Victoria, for paper on 'The Australian Aborigines.

1891 Rev. J. Milne Curran, F.G.S., Sydney, for paper on 'The Microscopic Structure of Australian Rocks.'

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1896 Rev. J. Milne Curran, Sydney, for paper on 'The occurrence of Precious Stones in New South Wales, with a description of the Deposits in which they are found.'

ISSUED NOVEMBER 30th, 1912.

Vol. XLVI. **Part I.**

JOURNAL AND PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES

FOR

1912.

PART I, (pp. 1-144).

CONTAINING PAPERS READ IN

MAY to AUGUST (*in part*).

WITH THREE PLATES.

(Plates i, ii, iii.)

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1912.

F. WHITE Typ., 344 Kent Street Sydney.

PRESIDENTIAL ADDRESS.

By J. H. Maiden,

Government Botanist and Director of the Botanic Gardens, Sydney.

[Delivered to the Royal Society of N. S. Wales, May 1, 1912.]

SYNOPSIS:

I. Introductory.

You called me to the high office I am about to vacate, partly to do me honour, for which I am very grateful, and partly to relieve me of work during a period of impaired health. For that I am grateful also, but while you have made presiding at your meetings such an entire pleasure, and while I have during the session vicariously eaten more than one good dinner as your representative, I have, on the other hand, for some time past been haunted by the spectre of the Presidential Address, which seemed indeed so very far away when the Council sent a kindly message to me fourteen months ago. And now the time has come for this duty, I cannot refrain from being retrospective to to some extent, as I look back on the address I had the honour of delivering before you just fifteen years ago.

The objects of an address of a President may be of several kinds. For example, it may include statistical and official records of the progress of the Society, year-book notes of the progress of science in Australasia, the Pacific Islands and Antarctica, and notes on local topics, or suggestions for the advancement of science, particularly as concerns our own State.

The opportunity thus presented to a President comes but once a year, and his notes, comments and reflections have many limitations and may not always be sapient, but they always receive the courteous and generous attention of the members of the Society at whose head he is temporarily placed. The greatest reward the President can experience is attained if his attempt to take the broad outlook, results in some of his visions implanting ideas in the minds of his hearers, so that the ultimate result may be, even in the humblest degree, that something may ensue to the advancement of science.

II. Necrology.

1. *Sir Joseph D. Hooker, Honorary Member.*—In my address of 1897 I deplored the death of the great Australian botanist, Baron von Mueller, who had passed away during my year of office, and now it becomes my duty to officially bring under your notice the death of our greatest British botanist, Sir J. D. Hooker, whom many acclaim as the greatest living botanist for a generation. Appreciative articles on Hooker and his work have freely appeared already, and I refer you to them for details of the veteran.

Sir Joseph Hooker was one of our Honorary Members and a Clarke Medallist of this Society; so also is Sir William Thiselton-Dyer, his distinguished son-in-law who succeeded him at Kew. Other ties with Kew are through the erudite Professor Daniel Oliver who is an Honorary Member, and Mr. W. B. Hemsley, another Honorary Member, who has published interesting articles on the botanist whose loss we mourn, and under whom he served for so long.

Our debt of gratitude to Hooker as Australians is two-fold. Firstly, because of his descriptions of Australian plants and elucidation of Australian botanical problems, and secondly, because of the interest he took in the welfare of Australian botanical institutions and of Australian botanical workers.

Hooker's father (Sir William) was a protégé of Sir Joseph Banks, and he had many reminiscences of the "The Father of Australia," which he had received through the intermediary of his own father, and thus he became a link with very early Australian history. Similarly he learnt from the paternal lips anecdotes and details of his father's fellow-townsman, Sir J. E. Smith, founder of the Linnean Society, and describer of many Australian plants, while he was, though much the junior, the fellow-worker of Robert Brown, *botanicorum facile princeps*, and the collaborator with George Bentham, the two most brilliant botanists whose names are engraved in the annals of Australian botany. It startles one to be told that he was botanist on the Antarctic Expedition "Erebus" and "Terror" (1839–1842), and that, until quite recently, he had pleasant chat of Sydney as he knew it, seventy years ago.

Darwin had paid a brief visit to our land a few years previously, and he and Hooker, both especially discriminating in their friendships, fortunately became attracted to each other, and the latter performed signal services to his friend, not only in enabling him to confidently (if such a word be applicable to Darwin) launch his "Origin of Species," and throughout the period of a long friendship, his well-stored and analytical mind was always at the service of his friend. It was especially valuable during that period, now a matter of history, of education of the public, of combating of ignorance and misrepresentation, of kindly guidance of those whose mental elasticity was not adequate to the sudden demand made upon it, and who, searchers after truth, found it through roads more or less difficult and long.

One of the grenadiers of the old fighting line has passed away, but not until the battle has long been won, and, visiting the fields of his exploits he could pardonably say

"But 'twas a famous victory!"

Hooker's Antarctic voyage led him to produce six splendid and famously illustrated (by Fitch) quarto volumes, two each entitled *Flora Antarctica*, *Flora Novœ Zealandiœ* and *Flora Tasmaniœ*. The last work is most familiar to Australians, partly because of the intimate relations of the flora of Tasmania and of the mainland, and partly because it contains the classical essay entitled "On the Flora of Australia."

He had many rambles in Tasmania with Ronald Gunn, and his active botanical correspondence with that gentleman and W. H. Archer, was only terminated by their deaths. Indeed he took an especial interest in the flora of that beautiful island.

He wrote less on Australian plants, partly because his opportunities for travel on the mainland were so few, (he visited Sydney and the Blue Mountains), and partly because he was not so fortunate, as in Tasmania, in obtaining coadjutors to correspond with him, and send him material, after his return to Europe. The loss was ours, for it would have been to the advantage of Australian botany to have had the vigorous and analytical mind of a Hooker focussed on more of our botanical problems.

It must not, however, be for a moment supposed that he was not greatly interested in Australian botany. For example, both his father and himself took great interest in the collections made by Drummond in Western Australia, while when a young South Australian and subsequently Victorian botanist, in the person of Mueller, showed himself making competent investigations of the Australian flora, he received continuous and substantial encouragement from the great man whose loss we now mourn.

He took the warmest interest in the *Flora Australiensis* prepared by his friend Mr. Bentham, while his active sympathy towards Australia, as the head of the great

establishment at Kew, was evinced alike in the cultural operations under his direction, as well as in examination and display of herbarium and museum material.

The Sydney Botanic Garden was greatly indebted to him for consignments of seeds and plants, and indeed, in his capacity as Director of the principal botanic garden of the Empire, he looked upon other gardens with a fatherly eye, and favoured my predecessor with circulars in regard to cultural and botanical matters, and when Mr. Moore discontinued his annual reports, Dr. Hooker addressed a courteous remonstrance to him on the subject through the medium of the Secretary of State. Personally I thank him for many kindly words. Indeed his interests were world-wide, and his physical capacity for work beyond that of the average man.

2. *The Lord Lister, Honorary Member.*—We have to deplore the demise of another honorary member, alike old in years and honours, Joseph, Lord Lister, who died at Walmer, on February 10th last.

Joseph Lister was born on April 5th, 1827. He was of Quaker stock, and received his early education at a school kept by members of the Society of Friends at Tottenham, near London. In due course he went to University College, London, whence he graduated at the University of London in Arts in 1847, and in medicine in 1852. He may be said to have grown up in a scientific atmosphere. As a student he came under the influence of Sharpey and of Graham. The teaching of these men, together with the great advantage of his father's example, gave him a powerful impulse towards the cultivation of pure science. His first investigations were mainly histological, but he did not neglect the clinical side of his profession. On the completion of his studies in London, he went to Edinburgh at Sharpey's suggestion, where he worked under Syme for some years,

first as House-Surgeon and afterwards as Assistant Surgeon at the Royal Infirmary. The earliest papers of this period were on the duration of vitality of tissues and on the structure of the plain muscular fibre. Another group dealt with the early stages of inflammation, with gangrene and with the clotting of blood; while a third group was concerned with the functions of visceral nerves.

In 1860 Lister was appointed Professor of Systematic Surgery at Glasgow University. In the wards of the Royal Infirmary he commenced his struggle with pyæmia, hospital gangrene and suppuration. Taking advantage of the discoveries of Pasteur, which revealed the cause of putrefactive fermentation to be the development of living organisms in the dust of the air, he applied the new idea to the treatment of wounds. It is unnecessary to repeat the oft-told tale of the evolution of modern surgery on the lines laid down by Lister. It is enough to say that, taking Pasteur's pregnant discovery as his guide, he studied for himself, with characteristic thoroughness, the action of micro-organisms in putrefactive fermentation in organic fluids. Next, with infinite trouble, he tried how the new principle could most effectively be applied. To gain any notion of the patience with which he worked his own papers must be read. It will there be seen that he would pursue a research for a score of years, ever seeking for sources of fallacy, for causes of failure, and for the often elusive secret on which success depended. How completely he succeeded is shewn by the history of modern surgery.

In 1869 he succeeded Syme in the Chair of Surgery at the University of Edinburgh. There he continued his work, devising and treating improvements in the methods of carrying out the antiseptic principle. At the same time he carried out researches on the germ theory of putrefaction and on lactic fermentation. In 1877 he left Edinburgh

for King's College London, where he persevered with his work until he retired in 1892.

Although he was subjected for many years to criticism, and was met by active opposition, his path was easy in comparison with that of most who are the first to see the silent sea of strange truth. Seldom have a scientist's merits been more signally recognized in his lifetime than those of Lister. He was elected a Fellow of the Royal Society of London in 1860 and became President in 1895. Societies all over the world showered honours upon him. He was created a baronet in 1883 and raised to the peerage in 1897.

Through his genius and industry he was fated to modify the life of every person subjected to the influence of civilisation. Where the pioneer carries the knowledge and practice of civilisation, into the wilds of Central Africa, into the islands of the Pacific or elsewhere, there he takes the discovery of Lister the first boon to uncivilised man.

I am grateful to Dr. H. G. Chapman, Acting Professor of Physiology in our University for the above account of Lord Lister's life-work.

3. *Brief memories of Baron von Mueller.*—Speaking of Mueller reminds me that nothing, other than a tombstone, has been instituted to commemorate him. As a working botanist, I still think that the memorial suggested at p. 41 of my 1897 address is necessary, viz., "A complete list of his works, with bibliographic annotations. The list should be in strict chronological order, with a botanically classified supplement. Such a list would find a place on the work-table of every student of Australian plants, and would go far to keep his memory green. The value of such a publication would be greatly enhanced if there were added to it reprints of some of his papers in obscure or rare serials at present they are lost to most of us."

One of his executors frequently announced his intention of writing a life of the Baron, but he probably realized that he had not the necessary technical knowledge, as he died without accomplishing anything. Meantime Mr. C. A. Topp, a competent authority, during a visit to England, made enquiries as to the encouragement he would receive in writing a life, and abandoned the idea. The probability is now that a full life of Mueller will never be written.

A well-informed life of this remarkable personality would have been very interesting, but the reputation of this great botanist is not dependent on an extraneous circumstance like this. His reputation rests on his published works, and any steps taken with the view of rendering his works more available and more complete, will enhance that reputation.

Personally I think Australia is poorer through no memoir of him as a man, having been published. I will leave aside the question of a publication concerning him as a botanist for the present. The late Dr. A. W. Howitt had, and the venerable Mr. Panton, late Police Magistrate of Melbourne, has innumerable reminiscences of the man who was invariably known as "The Baron." Mr. Panton is one of our best authorities in Australian geography and exploration, and on those subjects Mueller was intensely interested.

He was fond of homage from the younger men. For some years business and private affairs took me frequently to Melbourne and I always paid my respects to him. Except once, when I was making a very brief stay, and I was full of business. To my horror, he and his chum, the late Sir Frederick McCoy, bore down on me in Collins Street and the Baron gave me a good talking to. I had never made such a hole in my manners before, and on the next occasion of my visit to him, perhaps in the way of heaping coals of fire, he paid me the unusual compliment of seeing me into the old St. Kilda bus, and this is how he looked.

He was dressed in a rusty suit of black, with dress coat, the trousers very much too short, showing much blue-grey woollen stocking, while his feet were shod with sabots. Round his neck were several folds of muffler, made of angora wool, with the ends hanging down. The whole surmounted by a chimney-pot hat of unfashionable model, which had been brushed the wrong way. So long as he had clothes on, the cut or the age of them never entered into his head. He was the pink of courtesy, and sometimes it was difficult not to smile a little at him.

This angora scarf was historical, and was one of several that had been made from wool that Count de Castelnau, French Consul-General at Melbourne in the sixties, gave him. The Count was interested in acclimatisation matters, and certain Angora goats introduced into Victoria turned out very fine animals. An admirer of the Baron had the wool made into mufflers for him and this pleased him very much, for he was interested in all good works, his attention being by no means confined to botany.

On one occasion I had visited the Baron, and, as usual, had, after a visit of two hours, been unable to get a word in edgeways. As I rose to leave, he noticed that I was recovering from a cold and, before I could clearly comprehend, he unrolled his angora scarf from his own neck and quickly rolled it round mine. As he did this he said, "You know I am an M.D." (so he was, *honoris causâ*), and I thoroughly enjoyed the joke. When I got a little distance from the "baronial castle" (as it was playfully called), I removed the scarf, and returned it from Sydney, washed and folded, with grateful thanks. It came to me again by return of post with a letter of mild remonstrance. I am sure you will excuse these brief personal sketches, which are typical of the man.

He was one of the most charitable and unselfish men I ever met, and for many years he was in a chronic state of impecuniosity because he could never resist an appeal for help, while botanical expenses which might have been a charge against the public funds, were paid out of his own pocket to a large amount. So he told me many a time. He was a bachelor, and his personal expenditure was of the most modest description, everything went to science and charity.

On two occasions he thought about getting married. Once things went as far as getting the wedding-presents, and one of them, a clock, is in the Melbourne herbarium to this day. I think it was well that the wedding never came off. He could not possibly have found time for his wife's company, and it would not have been fair to put her into competition with, say, a new Eucalypt.

Some of his idiosyncrasies were most amusing. If he barked, which he did now and then, there was no bite. He was the quaintest and most picturesque figure I have ever known amongst Australian scientific men.—R.I.P.

4. *Our local death-roll.*—The hand of death has fallen heavilly upon our old members, we having lost no fewer than five, J. S. Chard, elected 1879; J. Percy Josephson, elected 1876; Houlton H. Voss, elected 1876; Norman Selfe, elected, 1877; A. B. Weigall, elected 1867.

John Sofala Chard was born in Sydney 16th October, 1853, and died at Manly, near Sydney, 1st July last. He joined the Survey Department in April 1867 as a volunteer draftsman, being promoted in 1869 to the position of field assistant, when he was attached to the party of Mr. Edward Twynam, then District Surveyor of Goulburn, but later Chief Surveyor of the Colony. Having passed with exceptional success the examination for license to survey,

he was appointed a licensed surveyor in January 1872, when he took up work in connection with the Tin Mines at Deepwater. He subsequently was attached to the Trigonometrical Survey, then under the superintendence of Mr. W. J. Conder, observing a considerable part of the primary triangulation in the Wagga Wagga District. About 1877 he visited Europe, returning in the following year. Shortly after his return he was appointed, (9th September, 1879) to the position of District Surveyor, being stationed at Armidale, which important post he occupied at the time of the inception of the Crown Lands Act of 1884, under which considerable changes were effected in the administration of the Public Estate. He resigned his appointment in the Lands Department in 1885, since which time he was employed in private practice as a surveyor, principally in the Maitland and Armidale districts. A short time before his death he commenced practice in Sydney.

From the commencement of his career he showed great promise, and came to be recognised as having great technical knowledge of his profession, being also possibly one of the most skilful draftsmen this State ever had. The higher branches of surveying specially enlisted his attention, and he made a very interesting addition to the methods of determining true meridian by devising a telescope diaphragm for observation of circumpolar stars. He took a great interest in all matters affecting professional status, and was for many years an active member of the Institution of Surveyors, New South Wales.

Joshua Percy Josephson, A.M.I.C.E., entered the service of the Public Works Department in the year 1868 as a cadet in the Harbours and Rivers Branch, which was then administered by the late E. O. Moriarty, M. Inst. C.E. He served his period of cadetship on engineering surveys in connection with the harbours on the coast, under the late

Mr. O. Rossbach. In 1872 he was engaged on construction work in connection with the building of the iron wharf at Darling Harbour, as Engineering Assistant to the Clerk of Works, for a period of three years. He was then engaged as Engineering Surveyor on some of the largest of the water supply schemes, and did a great deal of this work in connection with the Sydney Water Supply. He was also engaged as Constructing Engineer afterwards on the same work. The survey of the Goulburn Water Supply was also carried out by Mr. Josephson, in accordance with the recommendation of the late Mr. W. Clarke, who was engaged in England to advise the State Government in connection with the matter of water supply both for Sydney and several of the large country towns. Mr. Josephson acted as secretary to this Commissioner, during his visit to the State.

Mr. Josephson made an accurate trigonometrical survey of the Hawkesbury River, and also of the upper portion of the Parramatta River in connection with the subject of prevention of damage by floods. He also acted for a short time as principal assistant engineer, Field Staff, in the Metropolitan District, during the absence of Mr. Alfred Williams, M. Inst. C.E. Mr. Josephson retired from the Service early in 1896, and has since practised as a Consulting Engineer and Surveyor in Sydney. He was a Licensed Surveyor of many years standing, and has also been an Associate Member of the Institute of Civil Engineers since 1879. He was the author of a paper on the History of the Floods in the Hawkesbury River, read before our Society. He was born on 19th December 1852, at Sydney and died at Killara on 3rd October, 1911.

HOULTON HARRIES VOSS was born at Swansea, South Wales, on the 31st July, 1826, and died at Craigend House, Darlinghurst, Sydney, on 3rd August last. His father and grandfather were for many years the only bankers in the

town of his birth, and the Voss family have been buried in the Nicholaston Church Yard, Gower, ten miles from Swansea, since before 1600 A.D. He studied for a Civil Engineer under Nasmyth the celebrated mechanical engineer of Manchester, and after qualifying, sailed for Melbourne in 1852. The gold rush was in full swing at the time, and after paying a visit to the diggings, merely as a pleasure trip, he returned to Melbourne and went on to Sydney. Soon after his arrival in New South Wales, he was employed by the Government to superintend some bridge building near Camden, where he first met his old friend Mr. Jas. K. Chisholm. He practised architecture in and around Goulburn for a while, and it is stated that the last building he designed was the Goulburn Convent. He married Miss Emma Coghill, daughter of Captain Coghill, of Braidwood, early in the sixties. He was for some time Acting Water Police Magistrate in Sydney, and in that capacity, was present with the Duke of Edinburgh at Clontarf, when he was shot at by O'Farrell, who was afterwards brought before him. In later years he was Acting Police Magistrate at Goulburn, and in 1878 was appointed on the Royal Commission in connection with the Berrima gaol trouble. In 1870 he sailed for England, returning in 1872. Fond of travel, he went to and from England seven or eight times. Mrs. Voss died in Sydney in December 1907, and he was buried at Picton in the Antill vault with his wife and two children.

I am indebted to his nephew, Mr. Harold D. Voss, for these and other notes of the career of this fine old citizen.

NORMAN SELFE, M. Inst. C.E., was born 9th December, 1839 at Kingston-on-Thames, England, and died in Sydney 9th October, 1911. He arrived in Sydney in January 1855. He was specially interested in the Engineering Section, but he was a fairly regular attendant at the ordinary meetings of the Society until quite recently. He was articled to the

eminent engineering firm of which the late Sir Peter Nicol Russell was the head, later on joined the Gas Company, and was subsequently chief engineer to Mort's Dock and Engineering Company. He was a man of great breadth of view. For example, his ideas in regard to the provision of adequate wharfage accommodation for Sydney were in advance of public opinion at the time, but they have since proved to be fully justified. Similarly, his plans in regard to city improvement were characterised by a statesmanlike grasp of future requirements, and by much originality. He was a pioneer of Technical Education in this State, and was an authority on many subjects connected with the early history of New South Wales. He was a genial, unselfish, humble-minded man. He was remarkably well-informed on a variety of subjects, and I trust that one of the professional societies with which he was connected, will publish an account of the public activities of this excellent citizen. I know something of his worth, for I enjoyed his friendship for over thirty years.

ALBERT BYTHESEA WEIGALL, M.A. Oxon., C.M.G., was born in England about 72 years ago, and died in Sydney on the 22nd February last. He was one of the oldest member of this Society. His fame rests on his head-mastership of the Sydney Grammar School, which post he held for the long period of 45 years. When he took charge, it was a struggling institution with 53 boys on the roll; when he passed away, it had a roll of 602, and a noble record of achievement. Many of his pupils hold prominent positions in various walks of life, while of most of them it can be said that they are honourable citizens who have exercised good influence throughout Australia. He was a classical scholar, and not directly interested in scientific pursuits, but he always recognised the educational work carried on by our Society and was proud of his membership.

We also deplore the loss of our printer, Mr. Frederick Williams White, who had been associated with us for nearly half a century. He was also recognised in the trade as Sydney's oldest printer. He printed some of the sheets of our Vol. I, when we were the Philosophical Society, although the volume bears the imprint of Messrs. Reading and Wellbank.

As an editor of our volume for many years, I take the opportunity of testifying that he patiently bore with the vagaries of both authors and editors; he looked upon himself as to some extent an officer of the Society, and his relations with us were not entirely of a business character. As far as the oldest member of the Society can look back, we have only had one printer, and I record with gratitude his valuable services to the Society.

It is not generally known that he was more identified with Sydney's early scientific printing than any other man. He was printer of the old *Horticultural Magazine* in the early sixties; he was printer to the Linnean Society of New South Wales for a number of years, while he has printed for the Australian Museum a fine series of publications. I also bear testimony to the fact that his recreation was gardening, and that he had an accurate knowledge of our native flora, being a systematic visitor to the Botanic Gardens when his place of business was in William Street.

He was born at Taunton, Somersetshire, England, 19th September, 1832, was attracted to the Australian goldfields in 1853, having as fellow-voyagers Messrs. Burke and Wills, afterwards explorers, and Thomas McIlwraith, afterwards Premier of Queensland. Gold mining not proving a success, he very soon settled down to his trade as printer in Sydney, becoming a master printer in 1857 in William Street. He died at Rockdale, near Sydney, 2nd September, 1911.

5. *Portraits of Scientific Men of New South Wales.*—I desire to invite the attention of members to the desirability of systematically adding to the excellent collection of portraits which adorn our walls, especially of those of our early scientific men. The time is perhaps slipping away when some of the early portraits can be obtained. I am quite reasonable in the matter, since I would be content with photographic reproductions, though custodians of original portraits, busts, etc., might do well to consider the desirability of placing such in our care, either on loan or in perpetuity.

I have not worked the subject out, but my suggestions include the following:—

1. Group all portraits, as far as possible, according to the subjects specialised in by the originals.
2. No portrait to be hung of a living man.

Sir Thomas Brisbane was first President of the Philosophical Society of Australasia (1821), when he presided at an inaugural meeting which celebrated the jubilee of the landing of Captain Cook and Mr. Joseph Banks at Botany Bay. The members of that old and small Society should all be represented. They include Barron Field, Alex. Berry, Oxley, Uniacke, Allan Cunningham, Dr. Rumker, Captains King and Currie, R.N. A fuller list and other particulars of the 1821 Society will be found at *Trans. Roy. Soc. N.S.W.*, I, 11–14, from the pen of the Revd. W. B. Clarke. Alexander Berry was the last survivor.

I am familiar with the old records of this Society, and I find that no man attended the meetings more regularly and took a more active interest in the resuscitated Society (Philosophical, 1856, onwards), than Governors Sir William Denison and Sir John Young. Sir Edward Deas-Thomson was a most active worker. And how rarely do we now hear these names mentioned in connection with our Society. Is it right?

Medical Men.—Surgeon-General White, Denis Considen, D'Arcy Wentworth, and Cuthill should be included. William Bland, Hon. Dr. Douglass and Sir Alfred Roberts were all active members of our Society, though, it will be observed, I do not propose to restrict our portrait gallery to members.

Surveyors and Explorers.—We can hardly separate one designation from the other. The earliest surveyor-explorers include our first Surveyor-General Alt, buried in St. John's Cemetery, Parramatta; Surveyors Grimes and Meehan, G. W. Evans, John Oxley, Sir Thomas Mitchell, and many others. No doubt our Surveyor-General and our Institute of Surveyors would willingly help us.

Engineers.—When I come to Engineers, I find the title was somewhat loosely used, but whether some might be called surveyors or architects is a matter of detail. Let me suggest the following, and I am sure our Works Department and the Railway Department would help us. Major Druitt, W. H. Alcock, Superintendent of Streets, Highways and Bridges in 1810; John Busby, "Mineral Surveyor," of Busby's Bore fame. Captain, afterwards Sir E. Ward, a most attentive member. Col. Barney, R.E., G. K. Mann, R.E., E. O. Moriarty, Whitton, W. C. Bennett, three distinguished Engineers-in-Chief of the Public Works Department.

Architects.—Mortimer William Lewis of the Corps of Royal Military Surveyors, and first Colonial Architect. He was an early town-surveyor of Sydney, besides being in charge of engineering works. Then we must not forget such men as William Greenway, who dates from Governor Macquarie's time, nor E. T. Blacket, architect of the University, and of many fine churches.

Botanists.—These are attended to at the Botanic Gardens, so that attention can, in the meantime, be given to other kinds of portraits. If at any time the Society should

desire to make a collection of portraits of botanists, copies of all that I have accumulated would be at their service.

Zoologists.—Similarly, zoologists are attended to at the Australian Museum. A catalogue of the portraits in that collection could be kept at the Royal Society for convenience of reference.

Geologists.—We have a fine portrait of the Revd. W. B. Clarke, one of the fathers of Australian geology, and one of the most active office-bearers this Society ever had. I do not doubt that, if requested, Mr. Pittman, our Government Geologist, would help to make our collection of portraits representative.

Let me not forget the Astronomers, of which G. K. Smalley was an office-bearer, nor such men as Prof. Stanley Jevons, office-bearer, political economist and physicist.

Perhaps a circular could be issued to members asking them to suggest where portraits exist, and to help in any way. The Press would help us, and I am sure that the various Societies would, such as our good friends the Linnean Society of New South Wales, the Engineering Association, Institute of Architects, Institute of Surveyors, and so on. Our own portrait-book includes such men as Christopher Rolleston and J. F. Mann, the former a most active and useful member, and the latter an explorer with Leichhardt, and an authority on Australian geography and the aborigines.

The following prominent members of the Society are, for example, depicted in the Mitchell Library souvenir book:—Col. Barney, Canon Allwood, Sir C. Nicholson, Sir E. Deas-Thomson, F. L. S. Merewether, Alex. Berry, H. H. Browne, Prof. Smith, W. B. Clarke, E. Daintrey, Capt. Sir E. Ward, R.E., Wm. Macleay, W. J. Stephens; and I am perfectly certain the Trustees of the Library would help us to realise our modest ambitions.

The honorary secretaries have a good deal of detail work to do for the Society, and perhaps members with a little more leisure than they, and who wish to do real service to the Society, might consider the desirability of actively helping in this special work of getting the portraits together.

While I am in an historical vein, let me express the regret I feel that we did not emphasise our jubilee in 1906. A mere celebration would have been of little account had there been no permanent printed memorial of our history to date. I have accumulated a large quantity of material in regard to the history of that 50 years, which pressure of other duties prevented me offering to the Society. I will take care of these notes, perhaps add to them, and it may be that a successor of mine may find them useful in giving an account of the centenary of the Society.

III. Local Societies and Scientific Gatherings.

1. *The Melbourne Meeting of the Australasian Association for the Advancement of Science.*—This has been fixed for January 1913. The list of office-bearers is not yet printed, but I have seen it, and it shows a very strong team. We were glad to see many of our Victorian friends at the Sydney meeting of January 1911, and the best compliment we can pay them will be to accept their invitation and be present at their meeting in great strength. The meeting will afford the most appropriate opportunity for discussing formally and informally, arrangements for welcoming our British brethren, when they honour us by visiting our shores during the following year. Sydney being an important Australian scientific centre, it is desirable that New South Wales men should take an active interest in this particular meeting for the advancement o science.

2. *The forthcoming Australasian Meeting of the British Association.*—This will take place in August 1914,

practically two and a-half years ahead, and consequently the arrangements for the visit are not yet crystallised. The Premier of the Commonwealth Government, whose enlightened action has rendered it possible for the meeting to be held in Australia at all, has recently made the announcement that about 150 representatives of British science will attend. The arrangements made and contemplated, will be announced as far as possible at the Melbourne meeting of the Australasian Association for the Advancement of Science.

I refer to the matter thus briefly, to remind members of this Society of the approach of the most stupendous event in the history of gatherings of scientific men (and women) in Australia. I hope that members of this Society will not only become members of the British Association, at least for this meeting, but that they will even now begin to revolve in their minds in what way they can contribute to the enjoyment of our guests, both in the way of showing them the treasures of our scientific institutions, and in assisting them to a knowledge of our scientific and material resources.

3. *The sequence of early Scientific Societies in New South Wales.*—I have already referred to the 1821 Society, "The Philosophical Society of Australasia" of which ours is a direct successor. This was a purely scientific Society, and when it was found that, for many years, the small population of Sydney and of the colony generally, could not support a strictly scientific organisation, agricultural, horticultural and kindred societies took up the work, and afforded opportunities for scientific discussion, scientific lectures, and exhibits of scientific objects. I have for some years been collecting data concerning these societies, which kept the torch of science burning, and offer the following brief notes.

The Society founded in 1821 was mentioned in the "Australasian Almanac" for 1825, but not afterwards. It is probable the Society met for more or less informal discussions, which were recorded in the press. Then we have "The Agricultural Society of New South Wales," from 1822 to February 1826, which became "The Agricultural and Horticultural Society of New South Wales" from 1822 to 1836 (?). A few reports from 1822 onwards are in existence. Members of the Committee represented specific districts.

Prof. Smith in his Presidential address (This Journal xv, p. 3, 1881), says that "In the New South Wales Calendar of 1832, I find mention of an 'Australian Society' for promoting colonial products and manufactures, under the presidency of Mr. Samuel Terry. I can find no other reference to it." The full title was "for promoting the growth and consumption of colonial products." I find its office-bearers given in the N.S.W. Calendar for 1831, 1833 – 1836.

In Ford's "Sydney Commercial Directory" for 1851, we have "The Australian Society for the encouragement of Art, Science, Commerce and Agriculture in Australia, Sydney, 1850." This is what is known as the 1850 Society (our precursor). The above Directory (see also our *Trans.* Vol. I, 15, 16, for further particulars) gives a long list of office-bearers, including many names long identified with the Philosophical or Royal Society of New South Wales.

The names of the office-bearers are given in the "Australian Almanac" for 1852 and 1853, the Society being always identified as that of "Sydney, 1850." The relation of our Society to the 1850 Society has always been recognised, and I would like to see portraits of the office-bearers on our walls. The 1850 Society eventually got into low water through the excitement caused by the gold discoveries.

In the meantime "The Australian Floral and Horticultural Society" had come into existence. I know of it from

1836. Its office-bearers are given in the "New South Wales Pocket Almanac" for 1840. In the issue of 1841 it is referred to as the "Sydney Floral Society," evidently through carelessness, and in the issue of 1842 correctly. The "New South Wales and Sydney Directory" for 1843 mentions it, and I find no further mention of the Society, until in "The Australian Almanac" for 1848 it again has a full list of office-bearers, and I know nothing further of it under this name.

Then we have "The Australasian Botanic and Horticultural Society," founded in July 1848. It went on till 1856, and its office-bearers will be found in the various "Australian Almanacs." In November 1854 was founded "The Horticultural Improvement Society." This lasted till October 1856, when, with "The Australasian Botanic and Horticultural Society," it was merged in "The Australian Horticultural and Agricultural Society," which went on till 1860. Some of the members of "The Australasian Botanic and Horticultural Society" objected to the fusion, and 22 members, bringing with them £88, seceded, and helped to found "The Philosophical Society of Australasia," which is often referred to as the "1856 Society," receiving its name at a public meeting held 9th May, 1856. Some brief notes will be found in our Trans. I, 17. Our Proceedings are thenceforward recorded in "The Sydney Magazine of Science and Art" (1858-9), and those of "The Australian Horticultural and Agricultural Society" also. The differentiation became fairly complete.

Other societies worthy of mention in this connection are "The New South Wales Vineyard Association" (1852-3), see the "Australian Almanacs" for those years; "The Agricultural Society of New South Wales," (1860 to date); "The Acclimatisation Society" (1862 – 1874 ?); "The Horticultural Society of Sydney" (1864 – 1866 ?); "The Horticultural Society of New South Wales" (1869 to date)

IV. Other Scientific happenings of broad Australian interest.

1. *Northern Territory Expedition, 1911.*—The Expedition was organised by the Commonwealth Government, through the Department of External Affairs, for the purpose of investigating a number of scientific problems in the Northern Territory, and with a view to obtaining information to serve as a guide in formulating a policy for the administration of the country. The members were Professor Baldwin Spencer, University of Melbourne (leader); Professor Gilruth, University of Melbourne; Dr. Anton Breinl, School of Tropical Medicine, Townsville; and Dr. W. G. Woolnough, University of Sydney. The range of study included general biology, ethnology and anthropology, human and animal diseases peculiar to the country or likely to be introduced, geology and mining.

Professors Spencer and Gilruth visited Melville Island, a place hitherto practically unknown from the point of view of scientific investigation. The aborigines have always been fierce and hostile, but, thanks to the splendid influence of Mr. Cooper, a buffalo shooter who has obtained the confidence of the blacks, the scientists were able to carry on their investigations without mishap. Professor Spencer was able to examine a peculiar isolated type of aborigine, practically unaffected as yet by contact with civilization, and obtained very valuable results. At the present time he has returned to the island and is carrying his researches a stage further. Professor Gilruth was able to examine the buffalos, descendants of introduced stock, and to investigate their relation to the question of migration of the cattle tick.

The whole party journeyed overland from Darwin to the Roper Bar a distance of some 400 miles. Thence Professors Spencer and Gilruth and Dr. Breinl returned viâ the Roper

River and Thursday Island, while Dr. Woolnough continued the journey overland to Townsville.

The general biological results were not quite up to expectations, as the journey was made during the dry season. The dry and wet seasons are very sharply defined, and, during the former the lower classes of animals are very scarce. With the advent of "The Wet" they appear in great abundance and variety.

Ethnological and anthropological research gave most satisfactory results. At first the blacks were extremely suspicious, but Professor Spencer was able to allay their fears, and obtained valuable data referring to relationships, beliefs and ceremonies of five of the northern tribes.

Comparatively little stock was seen, but specimens examined showed the occurrence of cattle tick throughout the lower lying regions. Stock diseases, such as those termed "puffs" and "swamp cancer," prevalent in the wet season, were not much in evidence, but Professor Gilruth was able to obtain some information with regard to them.

Malarial mosquitos, as well as other kinds, were numerous, but no member of the party contracted the disease. Dr. Breinl concludes that malignant malaria, dysentery, and other tropical diseases, may be expected in increasing amounts as the population becomes greater, unless very careful preventive measures are employed. At the present time the population is fairly healthy. Owing to the shyness of the blacks, very little investigation of their health conditions was possible. Blood smears of human beings, and of animals of all kinds were collected, to be examined for parasites.

In spite of the rapidity of the journey, interesting geological observations were made. The Pre-Cambrian mineral

belt of the Territory, with its intrusive granites was examined. An enormous area of Cambrian quartzites, limestones and volcanic rocks was shown to exist, in which very little evidence of earth movement was apparent. The stratigraphy of the Cambrian rocks was made out. On the Barkly Tableland these rocks contain sub-artesian water, the conditions of whose occurrence were studied. A great development of hot springs was found along a line stretching across almost the whole width of the territory. The ancient gneissic rocks of Cloncurry were examined, and important suggestions bearing upon palæography obtained therefrom.

I am indebted to Dr. Woolnough for the above brief and modest sketch of an expedition which we owe to the broad mindedness of the Commonwealth Government, and I trust it will be the precursor of many similar expeditions under Government auspices, to regions very little known from a scientific point of view.

Professor Spencer, though engaged in engrossing duties, collected a fairly large number of plants, and although it does not appear that we have new species amongst them, several of them will contribute to our knowledge of geographical botany.

The various observations of the Expedition are being worked out, but the immediate results are two, and very important. One is that Professor Spencer accepted the offer of the Commonwealth Government to act as Chief Protector of the Aborigines for the Northern Territory for a period of twelve months, beginning with the present year, and not only will it result that valuable suggestions will be made for the welfare of the aborigines, but observations will be made in regard to the ethnology of certain native tribes, by an entirely competent and sympathetic observer. The second result has been that Professor

Gilruth has been offered and has accepted the post of Administrator of the Northern Territory, and he has just arrived at Darwin.

Scientific men throughout Australia, and I confidently include members of this Society, will applaud this action of the Government. It removes a working scientific man, one of ourselves, from the seat of his activity, and declares that he is not debarred from high administrative work because he is a scientific man. In other words, his appointment is a compliment to Australian science. He can now, from the very nature of things, have but little time to specialise in the scientific work in which he has won his spurs, but we know that, while carrying out his onerous and multifarious duties, his acts will be judicially influenced by the knowledge and sympathy of the scientific man. The collection of specimens and the making of observations he will have to largely leave to others, but in the newest of Australian countries, we shall feel that we have a sympathetic Administrator who has, as we think, the enormous advantage of scientific knowledge. His science and scientific sympathy will be brought out in various ways for the advantage of the Territory,—in what ways, we cannot say ; it is his function, as the man on the spot, to ascertain, and we will not importune him.

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The Department of External Affairs, Melbourne has commenced the issue of a *Bulletin of the Northern Territory*, 4to, illustrated. Bulletin No. 1, March 1912, is entitled "Report of (the) Preliminary Scientific Expedition to the Northern Territory, (by various authors). Bulletin No. 2, April 1912, is entitled "An introduction to the Study of certain Native Tribes of the Northern Territory,"(by Professor Baldwin Spencer).

2. *Antarctica.*—

Scott, 1910-11-12.
Amundsen, 1910-11-12.
Shirase, 1911-12.
Mawson, 1911-12.
Filchner, 1911-12.

The southern summers, 1910-11 and 1911-12, have been marked by a most determined assault on the strongholds of Antarctica. No less than five important expeditions, originating in five different centres of civilization—Britain, Norway, Japan, Australia, and Germany—have proceeded south to explore the last large unknown area in the World.

Scott's first expedition in 1903 showed that Antarctic exploration could be resolved into two types. There is the investigation of the animal and plant life and of the geological characteristics, which can only be studied *along the coasts* of the great Antarctic Plateau ; and, secondly, there are the sledging journeys to be made over the great *Inland Plateau*—the largest and highest in the World—which is devoid of life, and in which no rock masses project above the waste of ice.

Quite different objects are aimed at in these contrasted journeys. The first may be called purely scientific ; the second class also result in important additions to our scientific knowledge, but they are necessarily "dashes" marked by hurry, strenuous labour and great privation, and do not afford time for very careful scientific observation. Their chief aim, since Scott made the first long plateau journey in 1903, has been to reach either the South Geographic or South Magnetic Pole.

Of the five expeditions mentioned, Scott's and Amundsen's appear to be the only ones designed to attack the Geographical Pole. A glance at the map of the Continent will show that their winter quarters on the Ross Sea have

been established about 800 miles from the Pole. Mawson's expedition is working along the Antarctic Circle, 1500 miles north of the Geographic Pole, but fairly close to the Magnetic Pole, and perhaps actually *within* its area. The Japanese apparently had no expectation of reaching the Pole, but may perhaps be described as having registered their claim as an exploring nation. Lastly, the German expedition—one of the most completely equipped—has presumably entered the pack ice of the Weddell Sea at a point immediately opposite the Ross Sea region. Here Bruce, in 1904, found the permanent ice barrier covering a land which he named Coatsland. It is 1,200 miles from the Pole.

It will be seen that Amundsen, who placed his camp on the Ross Ice Barrier, remote from visible land, was concerned almost entirely with the attainment of the South Pole. But, in the course of his long journey, it seems probable that he encountered more new land than will be mapped by any of his friendly rivals. In addition to his advance to the Pole, Scott, relied no less on those members of his expedition remaining at head quarters and sledging west and north to increase the value of his expedition. Only half his officers accompanied him south, the remainder being engaged in subsidiary exploration and scientific work at three far-distant stations.

In the summer of 1910-11, Scott fixed his head quarters almost midway between Shackleton's of 1907 and his old Discovery Hut of 1902. Owing to his early start—28th November—he was able to complete his hut and leave for depôt-laying and exploration on the 24th January. He had time to lay a depôt of a ton of supplies near the 80th Parallel and even more at a point about one degree further north. Another important result was the experience gained in handling the ponies on the Barrier Ice and in blizzards.

Meanwhile, a second party under Lieut. Campbell, had been taken 500 miles east, by the "Terra Nova," to attempt a landing on King Edward VII Land. The ice conditions presented insurmountable difficulties, and on their return the ship sighted the "Fram," and found that Amundsen was settled on the Great Barrier, about 350 miles east of Scott's position. This news was left at Scott's headquarters, and then the "Terra Nova" carried Campbell's party north some 600 miles to Robertson Bay. Here they were landed in February, 1911, close to Borchgrevinck's hut of 1898. No other landing place was discovered in the whole region, though Captain Pennell made many attempts along the coast. However, the trip resulted later in the discovery of two new areas of land between Cape Adare and Adelie Land.

A third party under Griffith Taylor was landed at the foot of the Western Mountains in January 1911, primarily to continue the geological work of the 1902 and 1907 expeditions, both northward in the Dry Valley area and southward up the Koettlitz Glacier. Two geologists, a physicist who studied the ice conditions, and a seaman constituted the party. They found that the Dry Valley was a magnificent example of a "trog-thal" crossed by bars ("riegel") and exhibiting gorges and basins exactly as do the valleys of the European Alps. Small craters and great walls of late basaltic lava were perched on the older glaciated shoulders of the valley. The Koettlitz region was remarkable for the splendid examples of C W M (cirque) topography and empty hanging valleys below Mount Lister.

At head quarters, Dr. Simpson had encountered great difficulty, even in February, in setting up his instruments, in consequence of the violent weather. Nevertheless the anemometers, a thermograph, thermometers, and sunshine recorder, were placed on an adjacent hill 65 feet high.

Nearer the main hut was the small magnetic hut for absolute magnetic measurements. Alongside an ice grotto was cut out for the continuous magnetic trace, and it was ingeniously connected electrically to the hut, so that any accident to the apparatus was signalled by a bell. A portion of the main hut was devoted to meteorological and physical apparatus. It contained, *inter alia*, a Dine's pressure-tube anemometer—frequently consulted by the laymen—which registered every gust of wind as well as giving a continuous windgraph. The electrical condition of the air was frequently tested, while a wind direction chart was obtained each week. The outer temperature was recorded on a drum within the hut by means of specially designed apparatus.

There were in addition, thermographs and barographs of a more ordinary pattern. These continuous records were checked every four hours during the whole stay of the expedition at Cape Evans, by readings of standard instruments, and the two sets were found to agree excellently.

Mr. Nelson carried out experiments on the relation between the temperature of the sea water and the distribution of the plankton. A snow wall was built around a hole in the sea-ice, and this was kept open all winter. He collected specimens of sea water and carried out dredgings here, besides making soundings at regular intervals in the bay (through the ice) to map the extraordinary contours of this portion of MacMurdo Sound.

A tide gauge gave continuous records, and three distant thermometer screens on the sea-ice, and on the slopes of Erebus were of great value in discussing temperature distribution.

Of great value to the biologist and to the geologist are Ponting's photographs and cinematographs of the bird and animal life and of the scenery in the vicinity of the hut.

The whole party, except those with Lieut. Campbell, were united at the hut in May, 1911. During the winter and early spring, continued outdoor work was necessarily suspended, but Wright carried out pendulum work with apparatus lent by Berlin, of great interest in connection with the flattening of the earth at the South Pole. The geologists were engaged in mapping the local topography—a series of Kenyte outcrops covered by huge moraines exhibiting Kame features. The relations of the two petrological provinces, Kenyte and olivine basalt, occupied Debenham's attention. Numerous seals and penguins destined for food, were examined by Dr. Atkinson, and new protozoan parasites discovered. The most notable feature, however, was the heroic journey in midwinter to Cape Crozier. This was led by Dr. Wilson with the object of collecting the embryonic stages of the Emperor Penguin. Their five weeks journey in the dark, at a temperature frequently lower than 100° of frost, will long remain a Polar record. Three stages of the embryos were collected, and should prove of great value in the study of bird evolution.

Lieutenant Evans occupied the early spring in the careful triangulation of MacMurdo Sound, while later, Captain Scott led a short expedition across to the west, when he measured the movement of the Ferrar glacier (staked by the geological party in February), and discovered that a three-mile fragment of Glacier Tongue had drifted 60 miles to the north-west and stranded near Dunlop Island.

Dr. Simpson was very successful in sounding the upper atmosphere. His small balloons carried Dine's meteorgraphs up to distances as great as five miles, and most valuable and interesting graphs of temperature and pressure have been recorded.

The motor sledges successfully negotiated the twenty miles of smooth sea ice and then easily surmounted the slope up to the Barrier. They demonstrated the value of the tractor method of transit in polar regions, but, owing largely to overheating, they could not keep ahead of the pony party, and so were not taken beyond 79° south. Later, one was brought back by Day to the sea ice.

The Pole party started on November 1st, with eight ponies supported by two dog teams. In all sledging expeditions, temperature, pressure and weather conditions were noted at regular intervals in the day. These synoptic results—as already plotted—have yielded most interesting results in demonstrating the localization of many of the blizzards.

The collections and records of the Southern party have not yet been examined, and the last party had not returned when the ship was compelled to retreat on the 5th March, 1912.

The second geological party, under Griffith Taylor, set out early in November, for Granite Harbour, following thereto the route of Professor David in 1908. A large-scale chart of the coastline and hinterland, including Granite Harbour, the Mackay Outlet Glacier and the MacMurdo Piedmont was completed. Geological details were filled in by plane table on the spot, and the theodolite gave heights and azimuths not otherwise fixed. The contours and characters of the various retreating glaciers, glacier tongues, cirques, nunatakker, etc., were especially investigated and mapped.

A novel flora and fauna was found at this locality. Great masses of moss occupied the spaces between the boulders on the beach at Cape Geology (in the Harbour), although their continued blackened appearance indicated the severity of the summer. Yet thousands of small insects

(allied to the "Spring-tails") were discovered clustering in a half-frozen condition under almost every pebble hereabouts.

The survey was continued some forty miles from the main coast. Very interesting contact arears between granite and marmorised limestone were mapped in detail by Debenham, and several striking contact minerals collected. Below a hugh nunatak, 4000 feet high, many well-preserved fossil plates—keeled and an inch long—were discovered. Here also they obtained lumps of bituminous coal. Both were probably derived from the shaly bands of Beacon Sandstone which outcropped in the nunatak.

This party could not be relieved by the ship as arranged, owing to the immense fringe of pack ice—20 miles wide—which prevented communication of any sort. They, therefore, made their way back towards headquarters over the Piedmont Glacier, and so could survey and roughly contour the features of this type of glacier for the first time. The ship was able to reach them just a month late.

The Northern party, under Campbell, had spent the winter at Robertson Bay, making remarkably careful studies of the glaciers and ice conditions in the vicinity. The geology and meteorology of the district were studied in great detail. They were relieved by the ship early in January, and proceeded south to Terra Nova Bay (Lat. 75°), for five weeks sledging around Mt. Nansen. Unfortunately the ship was unable to pick them up owing to the early freezing-in of the pack ice, and details of their scientific work, both at Robertson Bay and Terra Nova Bay are still in great part unknown.

Scientific work has been carried out on the ship on all its voyages. Pennell obtained a new set of soundings on his course southward for a large portion of the route. The meteorological log linking Dr. Simpson's unique data from

the far south with that of Australia, should be of great value. Perhaps the most interesting branch, however, was that investigated by Lillie. He obtained numerous trawls throughout the area traversed, and was particularly successful in catching enormous quantities of the queer primitive vertebrate *Cephalodiscus*. All previous knowledge was based on half a dozen fragments.

Turning now to Amundsen's results, there are two features of outstanding interest—first, the meteorology at his headquarters, for this was the first winter spent by any expedition on Barrier Ice; and secondly, the light thrown by his splendid southern journey on the trend of the mountains near the Pole. No definite information appears to have been published on these points, but it seems certain that, although he experienced extremely low temperatures, probably considerably lower than those recorded at Cape Evans, yet his winter was practically a calm period. It is only necessary to glance through the British records to see that a continuous series of blizzards characterised every season. March, 1911, with an average hourly wind force of 25 miles, rising for many days above gale strength; April, May, June and July with average forces throughout the whole period, of 15 miles, culminating in July with a week's continuous blizzard over gale strength (38 miles), and with temperatures varying around fifty degrees of frost. One may hazard the explanation that it was the proximity of mountain ranges 10,000 feet high which accounted for this extraordinary difference, whereby the western region exhibits the wildest weather ever systematically recorded on the face of the globe.

From Amundsen's account, it seems probable that the Ross Barrier is really a hugh Piedmont glacier occupying a gigantic bay. To the south it is bounded by the prolongation of the Queen Alexandra Range discovered by

Shackleton, and there are indications of a N.E. trend toward Edward VII. Land. The latter may, however, be a tributary spur of a great range linking the Victoria Land mountains with the Andean Range of Graham's Land. Amundsen's discoveries weaken the possibilitiy of there being a belt of low-level Barrier ice connecting MacMurdo Sound and the Weddell Sea, which Filchner hoped to explore. Very interesting also is the permanence of the Great Barrier at the Norwegian headquarters. Although breaking away in great bergs between that point and Ross Island, yet it seems to be stationary and perhaps over-riding land above sea level, close to the Bay of Whales.

Mention must be made of Johannsen's sledging trip to King Edward VII. Land, where considerable areas of rock were explored, thus delineating the lands discovered by Scott in 1902. Probably never before has so much exploratory work been done by a party consisting of only nine men.

The work of the Japanese expedition is shrouded in mystery. The first summer (1910-11), their small ship was unable to penetrate further south than Coulman Island. The next summer they must have made a fine voyage for so small a boat, for they reached King Edward VII. Land, since both the "Nimrod" and the "Terra Nova" had been baffled by the ice in preceding years. They can hardly have spent much more than a month in southern waters, and their greatest accomplishment is probably to pave the way for future exploration by their enterprising fellow countrymen.

With regard to the two remaining expeditions, which started last summer, no news has been received of the German explorers under Filchner, while the Australasian Expedition has already made a good start, as recorded in the news brought back by Captain Davis.

Filchner proposed to land only a small party of eleven men, on the east coast of Whaler Sea, if possible. He hoped to decide whether the Antarctic lands were united into one plateau continent; or whether, as he thought possible, low-level ice barriers separated a Victoria Land segment from units comprising Graham Land and Enderby Land respectively.

The oceanographic work to be carried out on the "Deutschland" will probably bulk most largely in the German results. Already most valuable observations have been made at South Georgia, but these hardly come within the scope of this brief summary.

Lastly, we are glad to learn from Captain Davis that the Australasian Expedition has occupied three far distant stations. On Macquarie Island, nearly half way to his main base on the continent, Mawson has established a party primarily for meteorological observations. Wireless messages are continually received relating to the weather, which are invaluable in plotting the southern components on the Australian weather charts. Moreover, there is an area of 170 square miles awaiting detailed scientific investigation, and presenting numerous problems connected with subantarctic flora, fauna and geology.

The "Aurora" landed Dr. Mawson and his main party at Adelie Land, due south of Tasmania. There Captain Davis' charts show a fine extent of ice-free land awaiting exploration. So much exposed rock means good work not only for the geologist but for the biologist, for animal life is more abundant in these less inclement localities. The remarkable behaviour of the standard compasses hereabouts indicates a region of great magnetic interest, and it is certain that a station so near the Magnetic Pole, will produce results of paramount importance in that branch of

science. The "Aurora" then proceeded west along the land sighted by the American and French Explorers in 1840, but not visited since. The ice conditions were almost as unfavourable as those experienced further south by the "Terra Nova" at the same time, and interesting results should accrue when the two ice charts can be compared.

Captain Davis met with glacier tongues of unexampled extent and with great fragments from the Barrier thirty miles long. Ultimately, a sledge party under Mr. Wild, was landed in the neighbourhood of Termination Land and of the Gaussberg, where the Germans wintered in 1902. Here no bare land was visible, but very possibly some may be reached by Wild's sledging parties in the spring.

It is difficult to overestimate the value to meteorology of these well equipped stations working simultaneously in Antarctic areas. Some 600 miles from Tasmania is the Macquarie Island Station; again 600 miles south is the Adelie Land Station; yet another 700 miles south is Scott's main base, while twice that distance to the west lies the station on Termination Land.

I express my grateful thanks to Mr. T. Griffith Taylor, Senior-geologist of Scott's Expedition, who has just returned, for these interesting notes on the work of the five expeditions.

3. *The Prickly Pear.*—I made brief allusion to this pest at p. 57 of my 1897 address, and since then this weed plague has advanced by leaps and bounds.

Although numerous species of *Opuntia* are found in Australian gardens, public and private, I only know, for certain, that the following species have escaped from cultivation and may be said to be really acclimatised in Australia.

1. *O. aurantiaca*, Gillies.
2. *O. imbricata*, P. DC.
3. *O. nigricans*, Haw.
4. *O. inermis*, P. DC. var.
5. *O. ficus-indica*, Mill.
6. *O. tomentosa*, Salm-Dyck.
7. *O. monacantha*, Haw.
8. *O. Dillenii*, P. DC.
9. *O. microdasys*, Lehm.

10. *Opuntia sp.* A coarse species rare in Scone, New South Wales, bearing formidable spines, and with large, barrel-shaped orange fruits. I have seen what appears to be the same species from the railway train in the Rockhampton district, Queensland, but so far I have not been able to get specimens to make certain. It has affinities with *O. ficus-indica* or at least *O. amyclea*, Ten. It probably belongs to a very numerous group of Mexican species whose affinities are not well ascertained.

11. *Nopalea (Opuntia) dejecta*, Salm-Dyck.

The "*O. tuna*" of New South Wales Prickly Pear legislation is *O. nigricans.* Similarly "*O. vulgaris*" is really *O. inermis*, var., our Pest Pear, the true *O. vulgaris* being not known out of perhaps one botanic garden. "*O. brasiliensis*" of the same legislation does not occur in Australia except in one botanic garden.

One of the first duties to be undertaken by each State is to map out its pear-affected areas, and specimens of each pear should be authentically named. I have received information, on what appears to be good authority, that there are in Queensland two Opuntias not in the above list which are well acclimatised, and there may be more, but as I have not been able to get specimens, I cannot express an opinion.

Of those enumerated by me only one species, *O. inermis*, P. DC., is a really serious pest; I have styled it the Pest Pear of New South Wales and Queensland. It has become altered by its Australian environment, and hence it does not conform to the type. The evidence is too long to go into at this place, but I will present it at an early date, with a coloured illustration, in the Agricultural Gazette of New South Wales.

Individual plants are by no means so formidable as such species as *O. monacantha* and *O. Dillenii*, but *O. inermis* (the inapt species-name applies only to the spines and not to the smaller and more troublesome spinules) has proved itself fatally adaptable to the conditions of certain parts of New South Wales and Queensland. Its mighty progress is one of the wonders of the world in plant acclimatisation; this could only happen in the broad expanse of an imperfectly occupied continent.

A few years ago experiments, extending over four months, were made on Scone Common under my direction (Scone holds the unenviable notoriety of being the focus from which the Pest Pear spread) with the view of arriving at the most economical method of destroying the plants, and I recommended wounding the "bulb," the receptacle for reserve material, and spraying with a solution consisting of one pound of white arsenic, one pound of caustic soda or two pounds of washing soda, and 20 gallons of water was found useful.

I further suggested that an independent and impartial committee consisting mainly of local residents, certainly not with a preponderance of government officials, should be appointed to conduct experiments to ascertain (*a*) the best poison for spraying or any other method of application, (*b*) appliances for the application of poison, or for crushing

the plant or for dealing with it in any other way. I still think it will be desirable to take some such action as thus briefly outlined, sooner or later.

The Queensland Government has appointed a Committee of scientific men to investigate the pest, and this Committee has recommended the appointment of a botanist (a lady, Dr. Jean White, of Melbourne) to make experiments under its direction, with the view of having all methods of destruction recommended for test, subjected to the scrutiny of proper scientific investigation. We shall look forward to the result of these experiments with much interest, and we, partly for selfish reasons, hope that a really practicable method of pear destruction will be brought to light as the result of Dr. White's work, for we of all the Australian States, are most concerned after Queensland.

To some extent Dr. White's appointment is an innovation, so far as an Australian Government is concerned; it is adoption of a method, of tested value in the United States, where a scientific worker is detailed to work out a special problem, untrammelled by other duties of any kind whatever.

V. Some Botanical Matters.

1. *The teaching of botany.*—I propose to address you to night on various matters pertaining to the advancement of botany, horticulture and cognate subjects in this State. To some extent I shall refer to remarks made in my Presidential Address of 1897. I see most gratifying evidence of progress in plant knowledge, and am very pleased to note that our University will be very shortly free from the reproach that we have no Professor of Botany.

The effect of the appointment of such a man on botanical education will be immediate and important. In many primary and secondary schools botany will be taught because it is definitely recognised by the University, and

it will become a subject regularly included in the science curriculum of all educational institutions. Not only will the University teach students who desire to learn something of the subject for its own sake, but some of the future teachers of botany will receive training there. If the teachers be first taught, they will exert their infectious influence on impressionable minds far and wide, and very soon it will be no longer true of us that we have the most interesting flora in the world, but are not particularly anxious to learn about it. At the same time, I am far from suggesting that botany has not been taught, and well taught, at the University. Professor W. A. Haswell, D.Sc., F.R.S., the Professor of Biology, has been teaching it for nearly thirty years, and of recent years he has been ably supported by his assistant, Dr. S. J. Johnston. But botany has not had the *kudos* which it will have when its individuality is recognised by the foundation of a separate chair for this subject alone.

Mr. A. G. Hamilton, a trained teacher, well known for his original botanical research, has for many years been engaged in the practical teaching of botany to public school teachers in the Teachers' College, while Dr. S. J. Johnston, apart from his University work in botany, has been actively engaged in conducting botanical classes in the Technical College.

I have before me the "Courses of Study for High Schools," prescribed by the Department of Public Instruction for 1911. The courses extend over four years, and I find under the head of Biology (Botany), a General Course for Third and Fourth Year Students, and an Industrial Botanical Course for Agricultural Students in their First and Second Years. This teaching is under the direction of Mr. Hamilton.

Sir Joseph Banks wrote to his earnest protégé George Caley in March, 1795,

"I do not know there is any trade by which less money has been got than by that of botany . . . ."

Fortunately Caley was not discouraged, and he did excellent work, too little known, in New South Wales from 1800 to 1810. What Banks wrote has remained largely true for over a century, but botany, the Cinderella of the sciences, is coming into her own, and I can certainly indicate a more hopeful future for its votaries than when I addressed you fifteen years ago.

Botany is taught in all High Schools (Real-Gymnasia) in Germany. In this way students imbibe a love of this subject (I am only dealing with botany in this address), and often proceed to a wider knowledge of it later. The passing by the boy of the examination which qualified him to go from the classes known as Lower to Upper Secunda gives him the privilege of only serving one year with the army, instead of two years, the ordinary term. Now Germany is a country in which social distinctions are very marked, and anyone who has some social claims, from the small shopkeeper upwards, considers it a disgrace if his sons have to serve two years in the army, in common with peasants and labourers, and people who cannot or will not study. The boys themselves share this feeling.

It will be seen at once what a mighty spur this military requirement, grafted on the system of public education, is to the acquisition of knowledge in Germany. And knowledge is power and wealth, as the Fatherland well knows. It may be that the Commonwealth Government may find it desirable to put a premium on knowledge amongst youths drawn for military training, and then learning of all kinds, including science, will receive such an impetus in Australia as it can receive in no other way.

2. *A plea for a botanical survey.*—At p. 63 of my 1897 address I gave reasons in support of this plea, but the formal establishment of such a survey has not yet been made. During the past fifteen years I have seen with much pleasure, the steady increase in numbers of local botanists, and I feel that we are getting measurably near to the publication of serial "Records of the Botanical Survey of New South Wales," in which no new record would be accepted without quotation of a readily accessible and authentic specimen. Such a serial would relieve the already overburdened pages of our local scientific journals.

As regards my suggestion (p. 69, *loc. cit.*) for the posting of records in County and Parish Maps, I am as keen in regard to it as ever, but no funds are available to pay a man to do the work. I shall make a beginning, by publishing, in my "Critical Revision of the Genus Eucalyptus" coloured lines or "curving boundaries" on maps of Australia to embody our present knowledge of the range of each species. Publication of such maps (I am not referring to any particular genus) will, I am satisfied, very actively stimulate search in certain localities which appear to be indicated.

As regards a number of species, the full value of the maps will only be brought out when they are accompanied by indications of height above sea-level. Insets could also be inserted in each map with particulars of specific localities, *e.g.*, swampy, limestone, etc.

3. *New Census of New South Wales Plants.*—The endeavour of scientific classification of plants is to group them naturally according to their affinities, and their development from the lowest forms to the highest, but the so-called Natural System used in the *Flora Australiensis* is natural only in the principal groups, and not even that; the position of the Gymnospermæ as a group of the Dicotyl-

edonæ is quite unnatural. In Mueller's system of the *Census* some families are grouped more naturally, but he left the Gymnospermæ in their unnatural position, and he succeeded only in putting a new artificial system in the place of the old and very popular one. Alexander Braun's system, published in 1864, is the first system that has a real claim to the name "Natural System." A. W. Eichler's came next; A. Engler's, the system followed in the New South Wales Census about to be published, is the latest development. Of course no system can claim to be perfect. If all vegetable forms that lived in former periods of the earth had been preserved we would have a sure guide to a natural system, but how few and imperfect are the fragments preserved! Some isolated forms can be only placed tentatively at present, until later discoveries may show their true affinities.

Most important changes, revolutionising the whole nomenclature are made in the ferns. The system used in Hooker and Baker's *Synopsis Filicum* is based, within the Tribes, almost exclusively on the position and shape of the sori, and the position and shape or the absence of the indusium, and was followed generally by pteridologists, but it is almost as artificial as Linné's system, based on the stamens only. I will give here a few instances to what absurdities unyielding adherence by the old system to one character lead.

Aspidium ramosum and *Polypodium tenellum* are now called *Arthropteris obliterata* and *Arthropteris tenella;* the two Australian species and a third non-Australian one form the well-defined small genus *Arthropteris*, allied to *Nephrolepis*, but indistinguished from it by the leaves being articulate on the rhizome. The two species have the same venation, the same habit and have all characters in common, except one has an indusium and the other not,

and therefore one was placed with *Aspidium* and the other with *Polypodium*. Everybody who takes an interest in Australian ferns must have noticed the striking similarity of a certain group of *Polypodiums* (*P. proliferum, urophyllum, etc.*), with the genus *Nephrodium* in the *Synopsis Filicum*, or *Aspidium* (Section *Nephrodium*) in the *Flora Australiensis*; they clearly form one natural well-defined genus, but they were separated into two genera because the indusium is present in some species and absent in others.

The Division "Embryophyta Siphonogama" of Engler (Phanerogamæ) comprises the sub-divisions Gymnospermæ and Angiospermæ; the former have only a few living Families, but more extinct ones known only by fragmentary fossil remains, and are now recognised as a transition from the flowerless plants to flowering plants; the latter are divided into two classes Monocotyledoneæ and Dicotyledoneæ.

The Monocotyledoneæ are divided into series or groups of Families, and commence with the lowest following plants, the Typhaceæ, Pandanaceæ, Sparganiaceæ, Potamogetonaceæ, Najadaceæ, etc., mostly water and swamp plants fertilized by wind or water, and end with the most highly and developed Orchidaceæ. The Dicotyledoneæ are first divided into two sub-classes, the Archichlamydeæ (Choripetaleæ and Apetaleæ) and the Metachlamydeæ Synpetalæ (Monopetaleæ); the Archichlamydeæ commence again with the lowest families, the wind-fertilized Casuarineæ, Piperaceæ, Salicaceæ, etc., and end with the Umbelliferæ; the Metachlamydeæ commence with Pirolaceæ, Ericaceæ, etc., and end with the highest family of plants, the Compositæ.

There is being printed, at the present time, a Census of New South Wales Plants, by my colleague, Mr. Ernst

Betche and myself. We have had the matter in hand for some years, and are trying to present a useful publication.

The last Census of plants of this State, was published by my predecessor, Mr. Charles Moore, in the year 1884, and consists of nothing more than a list of phanerogams and vascular cryptogams taken from Mueller's Census, with the volume and page of the Flora Australiensis added.

In our Census the arrangement followed, as far as these plants are concerned, is based upon Engler's classification, and is the first Australian Census following this order.

The Pflanzenfamilien has not been slavishly followed, but we feel that it is more scientific to begin with plants of lower development and proceed to the higher, and, having decided on that, it is well to accustom oneself to the scheme. It is my intention to adopt the same arrangement in the National Herbarium, but I feel that it would be futile to do so before the issue of a revised Census.

The Census contains references to the changes proposed by modern monographers, references to good pictorial illustrations, to useful botanical descriptions and notes, and especially to information bearing on the inclusion of the species in the New South Wales flora.

The honorary specialists attached to the National Herbarium, viz.: the Rev. W. W. Watt for Mosses and Hepatics, Mr. A. H. S. Lucas for Algæ, the Rev. G. I. Playfair for Desmidaceæ, will, in addition to Mr. E. Cheel for Fungi and Lichens, supply tentative lists of the New South Wales plants belonging to their various groups. It is our intention to publish additions to the Census from time to time, on the same plan, so that it may be kept up to date.

4. *The use of Latin for botanical descriptions.*—The International Botanical Congress, Vienna 1905, resolved

that new descriptions of phanerogams should be in Latin. It had been proposed to accept descriptions in English, French, German and Italian, but it was stated that if that be pressed, a claim would be made for the inclusion of such languages as Russian and Japanese, both countries containing many good botanists.

The resolution was passed, and in my view, it should be binding on all botanists, otherwise we shall have a most undesirable state of things. The proper course for objectors is to seek to rescind the resolution in a constitutional manner. New Zealand botanists are loyal to the Latin language, and personally I have always obeyed the decision, much as I, for personal reasons, regret it. A good Latin scholar also a botanist, would look upon the matter as of small moment, but, in my case, translations of descriptions into Latin take up time which I would like to devote to other purposes, besides which, I am not proud of my Latin descriptions when I have done them. I at one time thought I might get out of the difficulty by paying a Latin scholar a fee, but I find that many botanical Latin words belong to the genus *canis*, and there seems to be at present no escape for the botanist.

5. *Alterations in botanical descriptions.*—I emphasise the danger of altering botanical descriptions of genera or species, except it is distinctly so stated. Such a man as Bentham could perform such a feat with a minimum of danger, but, as a very general rule it should not be attempted.

We want the *ipsissima verba* of authors, in order that we may form our own opinions, and alterations should not be made except for special reasons, and then they should be indicated in some way,—in italics or by brackets.

VI. Functions of a Botanic Garden and some local ideals and suggestions.

1. *Centenary of the Sydney Botanic Gardens in June 1916.*—Our Botanic Garden "growed" like Topsy, following at first the economic requirements of a colony formed under peculiar circumstances, and as regards the garden, we became scientific in spite of ourselves. The history of the garden is briefly as follows:—

The colony was founded on January 26th, 1788. The First Fleet came viâ Rio de Janeiro, where a number of economic plants were put aboard, while an extensive collection of seeds of vegetables and other plants had been brought from England. A little latter, plants and seeds were brought from India and the Cape.

There being a little alluvial land along the banks of the creek just west of Sydney Cove, a farm was at once established there, and the name Farm Cove commemorates this to this day.

What is the proper date of the foundatiou of the Garden? There is reason for fixing it at the foundation of the Colony, for the Rio plants and the seeds would have been planted as soon as the primaeval forest could be felled, and the ground prepared. The ground has been continuously cultivated ever since, *i.e.*, for 124 years. The welfare of these plants was one of Governor Phillip's earliest anxieties, and I have not the slightest doubt they found themselves in the ground, and watered from the creek, not later than the first week of February 1788.

The best land, close to the creek, would be dealt with first, and later on the land further from the creek would be worked by hoe and spade, for the stumps of the trees would preclude the use of the English ploughs. In this way the land for the cereals would be prepared, and the farm

established facing Farm Cove, the actual site of the Sydney Botanic Gardens.

The especially interesting character of the plants of New Holland soon became known in England, and the directors of botanical establishments and proprietors of nurseries competed eagerly for seeds and plants of this country. Plant "cabbins," tubs, and closed casks of living plants and seeds were shipped to Sydney by every opportunity and exchanges made. Thus at a minimum cost the best products of horticulture were despatched to Port Jackson, and although the mortality in transit was exceedingly great, the collections in the Sydney gardens rapidly advanced.

Heward, the friend and executor of Allan Cunningham, King's Botanist, and afterwards Superintendent of the Sydney Botanic Garden, told the elder Hooker that the Sydney Botanic Garden was "probably founded shortly after Governor Macquarie's arrival in 1809," but I will show presently that a somewhat later date is better.

In the year 1813 Mrs. Macquarie's Road, referred to in the inscription on Mrs. Macquarie's Chair, was commenced. This road was of a total length of three miles and thirty-seven yards, measured from the Obelisk in Macquarie Place. The road encircled the Domain, as then defined, and from the Chair to old Government House gates it passed through the present garden, *e.g.*, from the vicinity of Mr. Overseer Camfield's present house, along the north side of the stone wall. The old stone wall had therefore been constructed some time prior to the year 1813—I do not know the precise date. Mrs. Macquarie's Road was finally completed on June 13th, 1816. Besides that on the Chair, the inscription " Mrs. Macquarie's Road, 1816," may still be seen on a rock on the left hand side of the road up the slope after leaving the Corporation Baths.

The completion of Mrs. Macquarie's encircling road, and its record on the Chair was, I consider, the coping-stone of Macquarie's plans for the definition of the Garden and Domain. He then appointed a "superintendent of the botanic garden" to supervise the area which he had thus defined.

Mrs. Macquarie's Chair is, therefore, the true foundation stone of the Botanic Gardens; the date (13th June, 1816) inscribed on it is their official birthday. From this date the records of the garden, though often carelessly kept, are continuous, and it is the proper date for us to compute the approaching centenary of its establishment as a *bona fide* botanic garden. If I am spared till 13th June, 1916, four short years hence, I hope that I shall have the very great pleasure of welcoming you to take part in an interesting scientific centenary.

For many years I have been compiling materials for a history of these Gardens, and it may be that a copiously illustrated volume will form part of the memorial. In good time the Government will be approached, and no doubt some fitting method will be devised of duly celebrating the occasion. Perhaps the Royal Society of New South Wales may see fit to mark the day in some way.

2. *Functions of a botanic garden.*—The address by Dr. N. L. Britton, before the botanical section of the American Association for the Advancement of Science, 1896, is devoted to an interesting review of "botanical gardens." The word "botanical" in this connection, seems American, though it is sometimes also used in Australia. He classifies the four main elements as, (1) The utilitarian or economic; (2) The æsthetic; (3) The scientific or biologic; (4) The philanthropic. He expands these as follows:—

The Economic Element.—"In the broadest extension of this department of a botanical garden there might be included, to

advantage, facilities for the display and investigation of all plants directly or indirectly useful to man, and their products. This conception would include forestry, pharmacognosy, agriculture, pomology, pathology, and organic chemistry, and, in case the management regards bacteria as plants, bacteriology."

This "broadest extension" is not carried out in any one establishment in any part of the world, so far as I know. Buitenzorg is one of the most comprehensive, but even that establishment, with its large area of land, rich equipment and assistance, and direct and active patronage by a government which is less trammelled than that of any Australian one, does not attempt the whole of the subject under one administration. A purview of them shows at once that no one human being could but have a smattering of most. In our own State, forestry is dealt with by a State department, pharmacognosy by the University, agriculture and pomology combined by another State department, and so on. The Economic Museum of Britton is, in our State dealt with by the Technological Museum, (which includes a valuable collection of economic botany), and by the Agricultural Museum, which includes agriculture and forestry.

The Æsthetic Element.—This refers especially to the landscape element, and this is affected by the buildings necessary for the purposes of a garden,—museum, herbarium, libraries, laboratories and offices, glass-houses, minor buildings, such as a bothy, stables, workshops for the tradesmen other than gardeners, and workshops (potting sheds, etc.) for the gardeners, dwellings for the staff.

The landscape gardener has his limitations by reason of historical and rare plants, especially trees, which it were vandalism to remove, or in connection with which public sentiment is known to be strong. The historical plants and historical features of such old gardens as Oxford,

Dublin, Kew and Sydney, the Empire's four oldest gardens, require respectful treatment.

The Scientific or Biologic Element.—Dr. Britton shows how the relations of the scientific department to the economic and æsthetic are intertwined. He adds,

"The research work of the scientific department should be organized along all lines of botanical enquiry, including taxonomy, morphology, anatomy, physiology, and palæontology, and the laboratories should afford ample opportunities and equipment for their successful prosecution."

He makes reference to the sequence of botanical families in a "botanical system" so far as the arrangement of plants is concerned. Each garden must, however, work out this problem for itself. Speaking for Sydney, I may say that I have more than doubled the number of special beds, each devoted to a family in the garden. It is not likely that I can do much more in this direction, for the reason that the claims of landscape must ever be borne in mind, and do all we can, the arrangement of families must, from the nature of things, be more or less formal. Then the strict sequence of families as a rule would result in horticultural failure. Proximity of families means, as a rule, uniformity of horticultural conditions, and every practical man knows that allied families may require very different cultural conditions. So that the theoretical plan of the lecture-room, and the plan as capable of being effectively carried out in the garden, may be two different things.

A remark by Britton—

"The scientific possibilities of a botanical garden are the greater if an organic or co-operative relationship exists between it and a university, thus affording ready facilities for information on other sciences,"

I cordially endorse, and much can be done in Sydney in

spite of the fact that a couple of miles of busy streets intervene between the botanic garden and the University.

The Philanthropic Element.—This refers to the influence of the garden as—

"affording an orderly arranged institution for the instruction, information and recreation of the people,"

and also to the dissemination of facts to the public, in various ways, by means of the staff.

WHAT IS A BOTANIC GARDEN?

The name is very much abused. Many towns in Britain have places called "Botanic Gardens" or, more briefly, since time is short, "Botanics." They are parks, and they are often leased by a person, who makes his money by charging a fee for admission, and by providing attractions such as games, or he sells flowers and refreshments.

Then we have the purely scientific botanic garden usually attached to Universities. To these the public are not encouraged; indeed, in most cases they are not wanted. The tiny Botanic Garden at Amsterdam, almost entirely enclosed with wire-netting, to keep birds and some insects out, so that it looks like a gigantic fowl-run, is an extreme type of this kind. And yet this is the garden of the celebrated Hugo de Vries, whose requirements it has admirably met.

And then we have the mixture of park, flower-garden and strict botanic garden. Of this class Kew is a fine type, and we in Sydney do well to imitate *(longo intervallo)* so fine a model.

Even in Kew, the vast majority of visitors are mainly interested in the park or flower-garden aspect of the establishment. They are not botanical students primarily. So in Sydney we thickly coat the botanical pill with the sugar of a "garden of pleasure," a beautiful view of the

harbour from the flat and the natural amphitheatre which surrounds it, and with such display of flowers as can be seasonably maintained, after the necessary demands of the public departments for cut flowers in season are satisfied.

Then the average citizen, walking through his botanic garden, enjoys himself. He chats with his friend, he reads his book, he contemplates the changing scene of landscape, observes the manners and customs of his fellow men, or he rests,—simply approximates as far as he can to the ideal of "doing nothing," and thereby relieves jaded mind and body. Or, he takes his walking exercise along the paths or across the lawns, imbibing health by activity under pleasant extraneous conditions.

That is how the majority of visitors to a botanic garden occupy themselves. They take their botany mildly. Some of them imbibe a little in spite of themselves, and, like M. Jourdain in "Le Bourgeois Gentilhomme" say,

Vive la science !

A small minority of the public are seriously interested in plants from the botanic or scientific aspect. The number is increasing, year by year, and will increase, as facilities are given for teaching the subject, but let us be quite honest, and admit that the vast majority of the taxpayers are not botanists at all.

We in New South Wales have to work out our own problems, some of them the result of our special environment, and hence the experience of other countries can only help us as a guide, and we cannot slavishly follow models, however excellent.

So far as the Botanic Gardens are concerned, most people do not understand that it consists of living plants (Gardens and Parks) and dead plants (Herbarium and Museum). By far the majority of plants which reached a botanical

establishment, or are enquired about, are dried (*i.e.* dead) specimens, and in order to cope with the various problems which arise, a large herbarium (a botanical museum being mostly a supplement to the herbarium arranged in a special manner for physical reasons) must be maintained. The herbarium and the garden are indissolubly united, the one being unworkable without the other, and this is never questioned in the principal botanical establishments of the world, *e.g.*, Kew, Paris, Berlin and New York.

So that my references to a botanic garden are meant in the full sense of the word, and not in the maimed or restricted sense of those gardens which are mere parks or horticultural establishments. Sydney is a capital city and her botanic garden is truly a botanical establishment; it is also one of the oldest in the world.

Following are some of the functions of our principal botanical establishment as they occur to me:—

Training of Gardeners.

1. The pupils of horticultural and agricultural high schools should, as far as certain branches of horticultural work are concerned, be given facilities for work in the Botanic Gardens.
2. The Botanic Gardens will soon have to face the question of giving technical education in horticultural methods to apprentice gardeners, and even improvers. These young men should not be retained in the establishment for a period longer than say two or three years, in order that room may be made for others. Part of their horticultural training would be obtained in private horticultural establishments and in horticultural schools.
3. Furthering the aims of the Horticultural Association of New South Wales, and other societies of professional gardeners, banded together for mutual instruction.

The time has passed when educational institutions of any kind maintained by the public funds shall be looked upon as "close corporations." Broad views as to their functions and usefulness must be adopted to keep pace with the times, and the head of each institution should show adaptability to immediate public requirements and should intelligently forecast future development. But while rendering his institution of the greatest public utility, he must safequard its resources and its reputation.

Laboratories.

1. We require a comprehensive laboratory for physiology and morphology, and you will be pleased to hear that the Minister has taken preliminary steps with the view to filling the desideratum of a physiologist to be attached to the Botanic Gardens staff.

Obvious work for such a garden-laboratory includes seed-testing (the large herbarium and museum being indispensable for such a work); hybridisation of plants (existing efforts being capable of extensive development); phytochemistry of a preliminary character (as will be explained later); preliminary investigations on stock poisons for the Stock Department, and so on.

Supply (loan or gift) of Material.

1. Horticultural or exhibiting societies, a convenient method of bringing some plants before a specially interested section of the public.
2. University and Technical College (supply of material for teaching).
3. Public or popular lectures on botany and horticulture in a special hall within or adjacent to the gardens, so that facilities may be available for presenting abundant fresh material for illustrations of discourses.

I know something of the public demand for such information. In the early days of my directorship I used to give public discourses in the Gardens in front of the growing plants. These were so largely attended that the crowds could not help trampling the plants and verges in the vicinity of my stand, and so they had to be discontinued simply because they were successful.

Special work.

Then the gardens are available for the illustration of special botanical work such as Dendrology.

As regards the present activities of the Botanic Gardens, this does not appear to be a suitable opportunity to enumerate them, as I am, as far as possible, speaking in general terms. They exist for the advancement of horticulture and botany, being very wide in their ramifications, and while it is the duty of the Director to inform the public as to the scope of those activities, it is the duty of the people, and especially that part of it which is educated, to satisfy themselves that they really know what those activities are. Most educated people who enquire candidly affect surprise when the enquiry is over.

And, without any formal authorisation, I know I speak the sentiments of my brethren in charge of other scientific establishments in New South Wales. I appeal to members of this Society to make it a point of honour to visit and be acquainted with the scientific institutions of the State, and thus to be able to speak at first hand concerning them. In this way this Society will become more and more recognised as an additional factor in the advancement of science.

3. *An Arboretum.*—At p. 51 of my 1897 address I wrote that New South Wales did not possess a single arboretum of the first class. This statement still holds good. But public opinion is very much more interested in forestry matters than it was then, and in Mr. R. Dalrymple Hay a

zealous Director of Forests has been appointed. Not only is there increased desire to know more about our forests, but we have initiated the planting of indigenous and exotic trees, work which had been scarcely touched fifteen years ago.

I repeat my suggestion that it might be possible to set apart a moderate area (say two hundred acres), of Crown Lands in a suitable situation within forty of fifty miles of Sydney. It might be possible to establish within this area a Forestry School, where young men might receive education in forestry subjects under conditions as they exist in the State, and if the site of the arboretum were at no great distance from a natural forest, the educational potentialities would be greater still.

The next generation will probably establish a country branch of the Sydney Botanic Gardens, consisting of a readily accessible site of several hundreds of acres, within say thirty or forty miles of Sydney. It will be away from the smoke of a large city, and it should contrast, as regards its soil, with the natural barrenness of the Sydney garden. It should afford accommodation for (*a*) a geographical arrangement of plants, (*b*) an arrangement into families, with so much ground available that every family can be represented by the plants which will grow in the district, (*c*) economic; in this section endeavour will be made to cultivate typical specimens of as many economic plants as possible; some of them, not conspicuously important for their uses, may be placed under (*b*).

From its distance from the metropolis it would be very little visited except by serious students, and while it would not take the place of the Sydney institution, it would be found to fill a real gap in the State's requirements.

4. *Phyto-chemistry and the botanic garden.*—The too-early death of Dr. M. Greshoff of Haarlem, Holland, leads

me to remind you of his last, and indeed posthumous paper,[1] which contains wise observations on the relations of a botanic garden to the subject of phyto-chemistry.

The experiments referred to in his papers were made in the Jodrell laboratory of the Royal Botanic Gardens at Kew, and years before, he had been engaged in the chemical investigation of plants in another botanic garden,—that of Buitenzorg. He says,

"Strictly speaking, one might demand that every accurate description of a new genus or a new species should be accompanied by a short 'chemical description' of the plant."

He appeals for statements in descriptions as to smell and taste and anything which will serve as a clue to the chemist. He points out that some latter-day botanical purists omit such details. He affirms,

"it is necessary that such chemical investigations should *begin* in the botanic gardens themselves, because it is only there one can decide experimentally:—

1. What part of the plant is best suited for analysis, and also in what part of the vegetable period the active principle is most abundantly present.
2. Whether constituents occur in the fresh plant which disappear on drying.
3. What is the exact name and nature of the plant under investigation, and what are its nearest relations, or in what other species and genera does the same chemical constituent occur."

He gives other reasons for the establishment of a chemical laboratory *in* a botanic garden, but these will suffice.

Obviously, fuller subsequent investigations will be undertaken in chemical laboratories far removed (if necessary) from the location of a botanic garden.

[1] "Phyto-chemical Investigations at Kew," *Kew Bulletin*, 1909, p. 397.

It is our duty in either describing plants or publishing notes concerning them, to publish any information of our senses which is not clearly explicable. A case in point is the odours of grasses to which I have drawn attention in another place.[1] Perhaps cyanogenesis may be indicated in some instances and a saponin in another. The botanist can in such cases act as a pointer to the phyto-chemist and the vegetable physiologist.

In referring to odours of plants the line of demarcation between sweet and disagreeable odours is one which is not clearly understood at present. The odours of *Eragrostis*[2] and *Dysoxylon*[3] are cases in point.

Then varying degrees of what we know as "bitterness" should incite us to enquire as to the cause of such a property.

The rubbing of a Eucalyptus or other leaf in the warm hand as we pass through the bush, is an experiment of great value in the hands of an observant man,—it is qualitative in that it is a guide to the kind of essential oil in the plant, and obviously quantitative in addition. Indeed an observant man can, from experiments of this kind, say whether a particular species should be tested for oil on a commercial scale, or whether it will only produce small quantities, regardless of cost, for scientific investigation.

It would be the duty of a chemist attached to the physiological laboratory in a botanic garden, to work systematically through the fresh or other material than can best be obtained in such an establishment, chiefly applying qualitative tests, and leaving the quantitative work in most instances to other chemists. No chemist who desired an indication as to work for research need go away unsatisfied, and in many cases material could be offered to him. It however should be borne in mind that no plant is grown in

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[1] *Agric. Gazette, N.S.W.*, 1912, (not yet published).
[2] *Loc. cit.* [3] *Forest Flora of N.S.W.*, iii, 100.

a botanic garden on a wholesale scale, and anything in the way of a "crop," or a large quantity of indigenously grown material, would have to be sought elsewhere.

Phyto-chemistry will, after the preliminary researches of the laboratory of the botanic garden, be developed in two directions—

1. Economic or technological, where the raw material or its constituents is sought to be applied to the service of man.
2. Purely chemical, and in these researches the botanist and chemist may part company.

The phrase, comparative phyto-chemistry, refers to the connection between the natural relationship of plants and their chemical composition. In the old days the Linnean system of classification sufficed; it was superseded by a so-called natural system which at least attempted to group plants according to natural affinities. For one hundred years system has superseded system, and modifications have been proposed to the latest, all to record access of knowledge of characters and properties of plants. At no period in our history has the assistance of chemistry been brought more to the aid of this work than during the last few years.

We are very ignorant, even yet, as to the true affinities of most plants, and there is a great amount of research to be done in regard to the interesting vegetation of this land of ours. Every observation, no matter how simple, carefully recorded, is a contribution towards this end.

Plants are no longer classified according to a single character; every science, every observation is laid under contribution, and the skill and experience of the systematist are shown in the way he co-ördinates all the data, from whatever source they may emanate, for the purposes of an improvement, maybe a small one, of the grand scheme of classification to which allusion has been made.

Dr. Greshoff draws attention to two constituents of plants which are of especial interest to us in Australia.

1. The presence of hydrocyanic or prussic acid, which is of especial interest to us whose country is pastoral, farming and dairying.
2. The presence of saponins, which are probably the key to the cause of the acrid or even poisonous nature of some of our native plants.

And here let me say, that while one does not presume to doubt for a moment the facts as to the cyanogenetic properties of some of our grasses, it is not desirable to be careful (I do not say that anything extravagant has been said, but the very mention of hydrocyanic or prussic acid frightens some people), in making unreserved statements as to their poisonous nature, because evidence is abundantly available that under some circumstances, or during certain periods of the year, these grasses are eaten with impunity. We therefore require information as to the interpretation of results.

In the following Australian plants Greshoff finds hydrocyanic acid:—

Drimys aromatica, F.v.M.; *Drosera* or "Sun-dew." Some species are already recorded as harmful to cattle. *Macadamia ternifolia*, F.v.M., "Queensland Nut," leaves strongly cyanogenetic. *Stipa* or "Spear grasses."

The fringe of the subject has been but touched, and I am glad to see that Dr. J. M. Petrie is specialising in regard to this particular work.

Greshoff finds saponins in the following Australian plants: *Arrhenatherus avenaceum*, Beauv.; *Atriplex* "Salt-bush," in the seeds and leaves of certain species; *Gleichenia flabellata*, R.Br., characterised by a high saponin content. *Kochia*, various non-Australian species of salt-bush; the

Australian species should be examined. *Phytolacca* the common "Poke-weed"; *Pittosporum; Billardiera; Psoralea; Tetragonia expansa*, Murr., "New Zealand Spinach," the shoots contain much saponin. *Xylomelum pyriforme*, Knight, our "Native Pear," the leaf contains saponin. In view also of the fact that *Macadamia* is strongly cyanogenetic, it would appear that systematic chemical investigation of our Proteaceæ would promise useful results.

The question of chemical investigation of our native vegetation has more or less interested me for over twenty-five years, and it is a great pleasure to see the strides that have been made recently. The largely pioneering researches of Mr. H. G. Smith, published by our Society, have been excellent, and what we now want is a systematic phyto-chemical survey, family by family, of Australian plants. One result of this will be that unsuspected affinities will be brought out to supplement those relations already established as the result of morphological investigations. With most of our local workers, research of this kind is but an incident amongst more or less exacting daily duties of another kind, but such valuable phyto-chemical work on our native flora has already been carried out in every Australian State and New Zealand, that it does not require the prophetic vision, to see additional workers attracted to this field, for they have an assurance that patient work will inevitably reap a satisfactory reward.

5. *Wanted a Botanical Museum.*—I have already hinted that I think it may be fairly said that very few people have more than a superficial idea of the activities of a modern botanic garden. Many people, and educated ones too, look upon my sub-department as having simply the horticultural and disciplinary care of a garden (and some parks), and think that the prefix "botanic" is simply given as an explanation of the occurrence of labels on plants.

In other words that a botanic garden simply differs from any other garden in having its contents labelled with botanical names (the labels certainly detract from the beauty and restfulness of a garden), and in containing a number of plants which at no stage of their existence can be considered to be remarkable for beauty.

They probably do not reflect that the outside is the garden of living plants, the counterpart of the inside (the museum or herbarium), or garden of dead plants, incomparably more numerous than those of the living ones, and, unlike the living garden, containing plants from the poles and the equator. The reason is because we have not yet arrived at the stage at which suitable provision has been made for *the display to the public* of dead botanical objects. The time will come when the people will insist on having a museum which will do for botany what the Australian Museum does for zoology. I may neither be in office nor live to see it in full development, but I may say that daily for years past I have been accumulating botanical specimens for that botanical museum. And believe me, that botanica museum will be found to be full of interest. I speak with a certain amount of confidence because, as you are aware, this is not the first museum I shall have formed *ab initio*.

It is not within the range of practicability that the citizens at large will ever be freely admitted into the National Herbarium, but I think I am entitled to look forward, even in my time, to a capacious and well-lighted building containing, within glass frames, small specimens of every plant indigenous to this State, every weed and economic plant found in New South Wales, and specimens of every plant, showing the destructive activities of fungi, both large and microscopical. This seems to me to be perfectly feasible, and worth working for its realization within the next five years.

In a New South Wales museum, the first prominence should be given to plants of this State, but the plants of other parts of Australia and other parts of the world come only second to these.

A botanical museum should be arranged according to a botanical classification, not like the vegetable contents of a technological museum, which are grouped according to their uses, *e.g.*, the timbers together, the fibres together, and so on.

Nor should such a museum confine itself to taxonomy; it would confer untold advantage on botanical students if, by means of models, diagrams and actual specimens, morphology (including anatomy), and physiology were well represented. Special attention should be given to teratological specimens; indeed, I have been accumulating such for many years past. And when one contemplates the resources of the Botanic Gardens, it seems the greatest of pities that specimens, culled from its treasures, cannot be systematically collected, placed in a suitable museum, and labelled as to name, and to indicate the lessons they are able to teach. Such a museum should be richly supplied with pictorial illustrations, in natural colours wherever possible. The public like pictures, and well executed drawings of plants are always in flower, always in fruit.

It is not possible to separate the botanical museum from the herbarium, for the former forms an integral portion of the latter. It contains succulent and bulky fruits, gums and resins, pieces of timber, etc., which cannot be placed in their proper order in the herbarium, for physical reasons solely. It also includes certain models, pieces of apparatus, portraits of botanists, botanical scenes, etc., which could not, even if their bulk did not stand in the way, fittingly find so convenient a place in the herbarium.

The arrangement should be strictly botanical. In each Family should be found samples of seed, fruit, leaves, bark, wood, gum, crude fibre, and anything in any way illustrative or characteristic of the Family. There must be no overlapping other institutions which display vegetable products.

Coloured pictures of interesting garden and hothouse flowers, especially orchids, should be made a specialty of.

The present Botanic Museum in the Botanic Gardens is far too crowded, and because of this, many thousands of specimens for which there is no room are systematically stored as "supplements," until such time as the new museum is ready to receive them. Every curator of a museum knows that some objects present themselves but once, or very seldom, in a lifetime; the careful steward of the public collections will accumulate specimens as opportunities offer, and wait, more or less patiently, for a suitable opportunity of displaying them.

It would be a great pleasure to me to properly show my contemporaries all the specimens I have stored away, and if members think an adequate botanical museum should be part of the educational equipment of Sydney, I ask them to assist in educating public opinion with the view to bring it about.

6. *A Fresh-water Aquarium.*—In my 1897 Presidential Address, p. 14, I drew attention to the desirability of a Marine Biological Laboratory and Public Aquarium, and suggested a site in a conveniently accessible position, say in the Domain, for it. Some money towards the cost of a Biological Laboratory still remains interest-bearing in the bank in the names of trustees. No doubt posterity will get its aquarium, but those of us who have seen public aquaria in Europe would like to give New South Wales people an opportunity of seeing them now. The Council of the Zoological Garden has its eye directed to the matter,

and would like to add a marine aquarium to its other attractions, and no doubt means would be devised of co-ordinating a Marine Biological Laboratory to it. Such an institution would doubtless be affiliated to the University. Since a Marine Aquarium would chiefly rely upon its zoological side for its attractiveness, I, as a representative of botanical interests, cheerfully surrender this educational feature to the Zoological Garden, but put in a claim for a Fresh-water Aquarium (for plants, not for animals) to be erected within the precints of the Botanic Gardens. I contemplate the erection of an oblong building, in harmony with its surroundings, well ventilated, and not artificially heated. All round the building and along the centre, should be staging for the support of glass tanks, each containing one species of aquatic plant, and I know my zoological friends will not think me encroaching on their domain, if in each tank should be placed a few snails and fish, since the presence of such animals is necessary for the healthy growth of plants. The Aquarium Society of New South Wales, which is doing useful work in regard to aquatic plants (and in other directions), would welcome this Aquarium as a means of diffusing information among the people, while, since aquaria are so beautiful, and so fascinatingly interesting, a fresh-water aquarium would be popular from the very day of its opening. With the development of Nature Study in the Public Schools it is absolutely necessary to both teachers and scholars. I have been cultivating New South Wales plants in glass tanks for several years, but have no convenience for staging them, and so accidents happen to them, while display of them to the public is out of the question.

7. *Proposal for a Horticultural Hall.*—If a man desires to see exhibits pertaining to horticulture other than the plants themselves, he has to pick up the information the best way he can. He will certainly see some exhibits if

he visits the warehouse of a good seedsman; I do not know where else he can see them. But we require something more than that; in a new building a room entirely devoted to horticulture might contain such permanent exhibits as the following:—

1. Portraits of Australian horticulturists.
2. Portraits "Non-Australian."
3. Pictures of florists' flowers, foliage plants, etc., especially of forms created in Australia.
4. Pictures illustrating horticultural methods.
5. Pictures of gardens (public and private), parks, etc.
6. Landscapes.
7. Specimens (or illustrations) of approved horticultural appliances.
8. Illustrations of hot-house architecture and of park and garden architecture generally.
9. Plans illustrative of park and garden planning and engineering.
10. Statues (illustrations).

The above is a mere outline. What is wanted in Sydney is something more than that. The various horticultural societies, general and special, are weighed down with the expense of hiring halls for the purposes of their shows. It would be a legitimate utilization of a small area in the Botanic Gardens or Government Domain to erect upon it an ornamental building for the purpose of public horticultural shows, which societies might utilize free of charge for such and for their business meetings. The building would be of more than one storey. It would contain a large room for shows, and smaller rooms for business pertaining to shows, including the safe custody of show-stands, vases, etc., which give exhibitors a good deal of anxiety under present circumstances.

The exhibits above enumerated would form the nucleus of a permanent exhibition, so that the public, whenever they visited the building, would see something of interest.

The various Societies should have the right of charging admission to the room in which their show is taking place for the period of the show.

The value of land in a central position in Sydney is so enormous, that I see no prospect of a horticultural hall being erected at the expense of our horticultural societies. Only within recent years has the Royal Horticultural Society of London had a home of its own, and it has had a numerous and wealthy following to draw upon.

8. *A Council of Horticulture.*—I would go further, and, without interfering with existing societies in any way, suggest to them to use their influence in the election of a Council of Horticulture, which would legislate, or make suggestions, in regard to broad questions at present not touched upon, or only imperfectly, by the societies. For example, I have for many years invited New South Wales exhibitors to let me have typical specimens of every form newly named, with a written statement as to its pedigree. The response has been disappointing. I am certain that no one individual can take up work like this, and existing societies have not the machinery. In many cases erroneous statements are made in regard to new plants. They are said to be of such and such a parentage, whereas they are often sports fortuitously selected, and their parentage is unknown. I do not blame the original exhibitor for this; what he may have said about his plant is sometimes misunderstood, and, there being no writing on the subject, the supposed history passes from mouth to mouth till at last it may become positively untrue.

Now one of the functions of a Council of Horticulture (to be appointed by the horticultural societies throughout New South Wales and by the horticultural sections of the agricultural societies), would be to keep an official record of Australian horticultural creations, like a herd-book or a

stud-book, and with coloured illustrations officially marked as the types. All recommendations as to prizes and other honours for supposed new horticultural creations, should be subject to the approval of the Council of Horticulture. I believe that if the Council had but this one function to perform, its work would result in purifying records, and in crowning the meritorious work of hybridists and others, with the result that a very important filip would be given to the advancement of horticulture in our State. Other powers and duties could be conferred on the Council by the societies concerned from time to time, as they might deem desirable. If there were Councils of Horticulture in the various States, they should elect a supreme Australian Council, for discussion of the largest questions.

9. *Some Forestry Notes. Wood Pulp.*—The subject of forestry occupied a larger share of my last address than it will do in the present one. Our forest areas are being defined, and I trust that wise counsels will prevail in the allotment of certain tracts in perpetuity, or for as long a period as it is possible to bind posterity. With wise counsels, I am confident that few conflicts need arise as between agricultural settlement and the interests of forestry. Coastal New South Wales is one of the most richly endowed countries in the world as regards forest wealth, and an aspect of the matter calling for consideration, is that we are destroying many trees whose uses are unknown. If a certain tree, after due investigation, shall be proved to be worthless, I have no intention of pleading for its retention, but I do ask that the research staff shall be very largely increased, so that we shall have the satisfaction of knowing what to destroy and what to retain.

In this connection let me mention wood-pulp. The world's supply is diminishing, while the demand is increasing. Practically nothing has been done to ascertain the adapt-

ability of the contents of many members of our forests for their use. Accidentally a year or two ago it was discovered that some inferior logs of the Tasmanian Stringybark (*Eucalyptus obliqua*), which had found their way to England in spite of the vigilance of inspectors, made excellent wood-pulp. Surely this unlooked for result is full of promise, for we had looked upon wood-pulp as mainly the product of certain genera of Coniferæ not represented in our forests, and our hope mainly rested upon the examination (not yet undertaken) of the numerous species which go to form our brush forests.

The subject is of sufficient importance for a chemist to be detached for the special work of examining our timbers for wood-pulp. If we have no chemist with the necessary technical knowledge, one can be specially appointed from an American, German or Norwegian wood-pulp factory, and he should be employed for this investigation alone, without any other duties whatever.

Only a few weeks ago the chairman of the Society of Dyers and Colourists, read a paper on the German wood-pulp industry before the members of the London section of the society. He explained that, as ordinary spinning was impossible owing to the shortness of the fibre, the wood pulp was made into paper, which was then cut, rolled and twisted into a thread. From this thread there were manufactured tablecloths, hat-bands, carpets, suitings, mats, and decorative articles. Three shillings' worth of wood was worth £2 5s. as paper yarn and £7 10s. as artificial silk.

I shall be exceeding surprised if Australia, with her indigenous timber wealth is to be excluded from this valuable industry, and if pines of the genus *Pinus* form indispensable raw material, then the sooner we seriously undertake the planting of our sandy coastal lands with

pines the better. The work has begun. Such planting was long since done in the "Landes" of South-eastern France, and an important subsidiary turpentine industry will be established, to say nothing of the value to local agriculture and stock raising of belts of shelter trees systematically planted.

Our forest officers are so busy with the absolutely essential work of collecting revenue and of policing and inspecting the forests,—many of them have long, wearisome rounds, that they have little time to make specific investigations for the advancement of forestry science. Some little matters worthy of notice I drew attention to in my last address, and I will submit two more.

In another place I have suggested that each species of tree has a locality-focus or foci of best development, irrespective of political boundaries. For example, the Blackwood grows (or is assumed by some to grow) best in Tasmania, and hence the highest encomiums in regard to this timber are alleged to be only true when applied to the Tasmanian wood. Is this so? If there are foci of excellence, let us define them. Herein lies a clue, I think to the conflicting reports in regard to the same timber. A district or a State makes disrespectful remarks as to the quality of a certain timber, which another district, knowing that locally the same timber is good, resents, and thus arises a wordy argument and perhaps bad blood and interference with trade, simply because folks are arguing with different standards.

It has been freely stated that a certain timber is more durable (and this is generally understood to refer to durability in the ground) in the locality in which it was grown, than at a distance from it. Is this so? What are the data? If this be so, certain timbers will receive a more thorough test and will not be condemned simply because of their bad reputation in other districts.

SOME OBSERVATIONS ON THE BIO-CHEMICAL CHARACTERISTICS OF BACILLI OF THE GAERTNER-PARATYPHOID-HOG CHOLERA GROUP.

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(From the Laboratory of the Government Bureau of Microbiology.)

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Introduction.

This paper is the result first of all of a systematic attempt to classify the very numerous cultures stocked in the Bureau of Microbiology, which were, by preliminary tests, found classifiable under the "Gaertner" group of coliform bacilli, that is to say, bacilli which are closely allied to the normal inhabitants of the intestine of man, and other animals, the colon bacilli, but which though forming gas from various carbohydrates as do these colon organisms, yet differ notably by their failure to ferment lactose and saccharose and by their action on milk, and which have very special relationships with certain definite pathological conditions in men and animals.

For the purpose of this classification I have made use, in the present contribution, entirely of the biochemical tests which attempt to orientate an organism by means of its mode of action on a series of test chemical substances familiarly known as the "sugars."

In this paper I have shown that organisms of the Gaertner group recovered from cases of paratyphoid fever—from cases of food poisoning—from cases of yellow fever in man

and from certain diseases in animals, notably from swine fever, show certain well defined biochemical attributes which demark them from most other coliform bacilli, but which, with one exception, are of little use in separating types in the group. The notable exception is that of the organism found associated with swine disease; this is distinctly marked out from the rest of the group by its apparently absolute inability to ferment arabinose, a pentose sugar readily attacked by all other members of the group.

The biochemical work in this paper has been repeated frequently, and twenty-two tests have been employed in the attempt to differentiate the group. Much of the work done here is substantially in agreement with previous workers, but, as far as I am aware, has never before been attempted by one author on such a large number of organisms and with such a large number of tests.

The use of arabinose as a differentiating agent between the swine bacilli and the remainder has not so far been noted, although at least one authority had he gone a little further must have made the discovery.

The rest of the paper is made up by a review of certain organisms similar to, but differentiable from, the true Gaertner-Paratyphoid-Food poisoning or Swine disease strains. These are especially interesting, as the reactions given by these organisms are in most cases very close to the true type, and might, unless especial care be taken, be mistaken for the true type.

A note is made of one true to type Gaertner organism isolated from the blood of a case of erysipelas, from which streptococci were also found. Also appended are the biochemical reactions of certain organisms of very different type, but which, resembling in some few respects biochemically, and also in their pathogenic relationship,

the Gaertner type, have been in the past classified in that group.

It would be advantageous if some common name were definitely agreed upon to describe the organisms now under discussion. Even the above triple title does not truly include all members of the category to be dealt with. As Gaertner was the first to describe an organism of this group, I will, in the rest of this paper, as I have upon previous occasions,[(1)] use the term "Gaertner Group" (or "Type") as a collective expression to describe bacilli of this order including b. paratyphosus, b. enteritidis of food poisoning, b. danysz (rat virus), b. icteroides, and b. hog cholera.

Organisms of the Gaertner group are fairly widely distributed in nature especially in association with certain pathological conditions in men and animals. That first found was isolated by Gaertner[(2)] from the flesh of a cow, eating of which had caused fifty-three cases of gastroenteritis, with one death. Thereafter similar organisms have been detected, not only in a great number of food-poisoning epidemics, but in numerous other situations presently to be referred to. Nowadays it is recognised that there exists a group of bacilli morphologically similar to the bacillus typhosus (Eberth Gaffky), which have, however, many of the characteristics of bacillus coli communis, but which can be sharply enough separated from either of these, and which in themselves form a well-defined group allied by a number of characteristic properties, even if showing amongst themselves certain differences. Since the discovery of the first member of the group, they have been isolated from an ever-widening range of sources.

History of the Gaertner Group.

It is not my intention here to go fully into the past history of the Gaertner group, or to attempt to give a

complete list of the situations in which organisms belonging to it have been found, but the following short summary will give a general idea of both these sides of the question.

After the discovery in 1888 by Gaertner, very numerous observers found closely similar, if not identical, bacilli in connection with numerous outbreaks of food poisoning. Recent work bearing on the subject of food poisoning associated with a Gaertner type organism has been done by Durham (1898–1899),[3] Delepine (1903),[4] Pottevin (1905),[5] Morgan (1905),[6] MacConkey (1906),[7] Savage and Gunson (1908),[8] Bainbridge (1909, 1911),[9] MacWeeney (1910).[10] Ostertag's Handbook of Meat Inspection[11] gives a good resumé of the earlier epidemics and work done up to 1896. A convenient name for such food poisoning bacilli is bacillus enteritidis.

Organisms have also been found in association with pathological conditions, other than food poisoning, in man, which have ever been relegated to the Gaertner group.

Nocard[12] as early as 1892 found organisms associated with a disease in parrots communicable to man, known as Psittacosis, which also belong to the Gaertner group. Gilbert (1895)[13] noted the association with various morbid conditions of bacilli akin to b. coli communis, but showed that some of them differed in particulars which we now know are characteristic broadly speaking of the Gaertner group. The work of Achard and Bensuade (1896),[14] Widal and Nobencourt (1897),[15] still further showed the relationship of Gaertner type organisms to disease in man, but it was unquestionably Gwyn (1898),[16] who first recovered an organism definitely Gaertner type from a case clinically typhoid fever. In his case the Widal reaction was negative to b. typhosus down as low as $\frac{1}{1}$, whereas the isolated organism was agglutinated up to $\frac{1}{200}$. The carefully worked out data of this case form the real starting point

of the modern conceptions of the relationship of such organism to cases of paratyphoid fever, and one sometimes is inclined to resent the way German authors especially, pass over this American's work in favour of Schottmuller's first contribution. The work of Cushing (1900)[17] and Schottmuller (1900 and 1901),[18] Libman (1902),[19] Longcope (1902),[20] Johnston (1902),[21] Hewlett (1902),[22] Boycott (1906),[23] Ruge and Rogge (1908),[24] Bainbridge (1911,)[25] as well as that of other authors have clearly shown that in certain generally mild cases clinically enteric fever there can be recovered bacilli of two types which are generally known as paratyphosus A and B, the latter of which is, culturally, practically identical with Gaertner's original B. enteritidis.

In 1897 Sanarelli[26] isolated from a large number of cases of yellow fever, a bacillus subsequently shown by Reid and Carroll[27] to belong to this group, and though subsequent investigations have not confirmed his original opinion that it was the *cause* of this disease, it seems well enough established that its frequent association with the disease is substantially correct.

Another important situation in which Gaertner type bacilli are found is in association with "hog cholera" now conclusively shown by Dorset, Bolton and McBryde[28] and others, to be caused by a filter passer. Here it is almost certainly to be reckoned as playing a very important, though subsidiary part in the causation of the disease.

A filter passer caused disease of guinea pigs has also been shown by Petrie and O'Brien,[29] O'Brien,[30] to be associated with bacilli of the Gaertner group.

Normal guinea pigs, MacConkey (1906),[31] mice and occasionally normal pigs, Savage (1906-7),[32] have been shown to harbour similar bacilli. Savage also found a Gaertner type organism in a healthy calf.

Members of the group have been found in normal stools, Castellani (1910),[33] food stuffs, Mullens (1904),[34] and Savage (1906-7), and certainly in one case in a water supply, May (1911).[35]

The organism found by Thomassen (1897)[36] in calves suffering from nephritis and cystitis probably also belongs to this order.

General Characteristics of the Gaertner Group.

These organisms all belong to the great colon family by virtue of their morphology, staining reactions, nature of growth on agar and their failure to liquefy gelatin or peptonise milk.[1] Certain of their biological attributes are now generally recognised, and the following description will, I think, be an accurate enough presentation of present day views on the characteristics of organisms certainly able to be included in the group. They all agree with bacillus coli in morphology and staining reactions. They may or may not be motile. They, like b. coli, do not liquefy gelatin or peptonise milk : and they differ from b. coli, in not fermenting lactose, not clotting milk, and in producing little or no indol ; and from bacillus typhosus in producing gas on glucose. I think it is recognised also that cane-sugar should not be attacked, and that acid and gas should be produced on mannit, *i.e.*, that such non-mannit fermenting organisms as Morgan's No. 1, and such saccharose fermenters as are fairly commonly found in fæces should be relegated to quite different categories.

The object of the paper is to enquire into the bio-chemical characteristics of organisms agreeing with the above description. The two principal methods used to identify and classify Gaertner type organisms are the agglutination method, including also Pfeiffer's test and the absorption

[1] Not obviously though the "clearing" referred to later may be of this nature.

method, and the bio-chemical method. Without discussing the value or otherwise of the first procedure, I intend to confine myself here to the consideration of the latter.

The history of the use of the changes produced by organisms on various chemical substances is a long one, and I do not pretend to give it more than a brief consideration, but before proceeding to my own work I wish to refer to the finding by certain observers who have specially entered into the matter.

Silberschmidt (1895)[(37)] noted that b. hog cholera fermented glucose with the formation of acid and gas and produced no indol.

Widal and Nobencourt (1897)[(15)] describe the organism they isolated from a thyroid abscess as a gram negative bacillus, non-gelatin liquefier, pathogenic for guinea pigs and mice. On glucose and mannit acid and gas were produced, lactose and saccharose were unaffected.

Thomassen's (1897)[(36)] nephritis organism was almost certainly Gaertner type to judge by the agglutination results. He describes it as an actively motile organism resembling b. typhosus, not liquefying gelatin, growing in an "invisible" manner on potato. Milk was not coagulated up to three weeks. Glucose was fermented, acid and slight gas being produced—no action occurred on lactose. It produced a slight trace of indol and was very virulent.

Gwyn (1898)[(16)] describes in some detail the organism he recovered from the blood of a case clinically typhoid. This is the first "paratyphoid" on record. It was a gram negative flagellated organism showing on gelatin "blue" colonies. It produced acid and gas on glucose, mannit and levulose (slight action on saccharose).[1] No action occurred on lactose. Milk showed "cameleonage," being first acid then neutral within ten days.

[1] This is not confirmed by later observers, and was probably due to traces of glucose in the saccharose used.

Durham (1898)[3] gives the bio-chemical characteristics of various Gaertner type cultures. He found, using 1% peptone water solutions of the "sugars," that all gave acid and gas on glucose, mannit, levulose, maltose, dextrin, and no action on lactose, cane sugar, starch, and inulin. On litmus whey, acid was followed by alkalinity. He states that with 2% peptone and 1% of either mannit or glucose, the initial acidity is followed by alkalinity.

Schottmüller (1900)[38] describes an organism from a case of enteric-like illness and differentiates it principally by serum reactions and gas formation.

Cushing (1900)[17] found a bacillus, "bacillus 'O'," from an abscess following a case of ? paratyphoid fever. Glucose was fermented and "cameleonage" and liberation of the fat (clearing) of the litmus milk occurred. The organism was actively motile. Indol was not produced in peptone, but a trace occurred in sugar free broth. He quotes a similar finding in a post-typhoidal rib abscess by Blumer.

Durham (1900)[39] in attempting to classify the colon-typhoid group by means of various sugars, etc., gives some considerable attention to the Gaertner type organisms. He distinguishes :—

I. A true Gaertner type in which he includes bs. Gaertner, Moorseele, aertryck, hog cholera, typhimurium, psittacosis and morbif bovis, etc. These he describes as forming acid and gas in glucose, and none in lactose and cane sugar. They give preliminary acidity followed by alkalinity in litmus whey.

II. A type including b. Gwyn and b. "O" Cushing. These he found, while giving abundant acid in glucose, gave free gas only under certain circumstances. Lactose was not affected.

III. A group consisting of organisms which showed a "colon-like" instead of a typhoid like morphology. Some of these gave acid but no gas on lactose not affecting saccharose. Others gave no action on lactose. The milk whey reaction differed from that of Group I. Sometimes milk was clotted.

Schottmüller (1901) describes two paratyphoid organisms and differentiates an A. and B. type. The type A. paracolon according to him rendered the milk slightly and permanently acid, while the B. type produced eventual alkalinity.

Longcope (1902),[20] describing two paratyphoid organisms isolated by him from the blood of two cases like enteric with negative Widals, found that one of these produced eventual alkalinity on milk while the other showed merely a gradual return to neutrality. Both organisms produced acid and gas on glucose and mannit, and no reaction on lactose and saccharose. Indol was negative.

Hewlett (1902),[22] describing the paratyphoid organism "Noonan," isolated from the blood of a case, notes cameleonage, acid and gas on glucose and no action on lactose and saccharose.

Libman (1902)[19] gives the reactions of a paratyphoid organism he himself recovered from the blood, bile, urine and spleen of a rather anomalous typhoid-like case: acid and gas were found on glucose and mannit, no action occurring on lactose or cane sugar. Milk was transitorily acidified and later alkali was produced.

Johnston (1902)[21] isolated from the blood of two case paratyphoid organisms, these he tested with numerous other strains, and agrees with the differentiation into A. and B. types.

Pottevin (1905)[5] gives a careful description of a Gaertner type organism isolated from ham. On glucose, mannit, maltose and galactose, acid and gas were produced, acid only on glycerine, and no action on erythrit, lactose or saccharose. The organism was pathogenic to guinea pigs and certain other laboratory animals.

Morgan (1905)[40] investigated the bio-chemical reactions of a number of Gaertner type organisms (b. Gaertner, b. aertryck, b. Moorseele, b. Hanstedt, by Breslaviensis, b. morbif bovis, b. Gunther, b. Abel, b. Renfleth, b. typhi murium, b. psittacosis, b. hog cholera Theo. Smith, b. hog cholera Evans, b. paratyphosus Schottmüller A, b. paratyphosus Schottmüller B, b. paratyphosus Brion and Kayser A.

He found that all of these organisms gave acid and gas on glucose and mannit, but no action on lactose and cane-sugar. Paratyphosus A and B, produced indol in five days. Paratyphosus A. produced acidity on litmus milk which was permanent up to a month. B. hog cholera Smith, produced no change on dulcit up to fourteen days. With the exceptions mentioned above, all produced acid and gas on dulcit and "cameleonage" on litmus milk. Morgan says that b. paratyphosus produces alkalinity less rapidly than b. Gaertner, which may do this in forty-eight hours.

Sacquepee and Chevrel (1906)[41] describing the characteristics of various paratyphoid organisms, note that on glucose, levulose, maltose, galactose, acid and gas are produced. Arabinose, dulcit, and mannit are likewise attacked, but less readily, and on arabinose in anaerobic conditions no gas is given off. Glycerin is even less readily attacked. It is not quite clear to me whether they found gas given off on the glycerin.

Boycott (1906)[23] gives the reactions of various Gaertner types: b. paratyphosus Schottmüller A (Brion and Kayser),

b. paratyphosus Schottmüller B., b. Aertryck, b. Gaertner, L.I.P.M., b. Gaertner orig. A. He says that on glucose, levulose, mannit, dulcit, maltose, dextrin, galactose, arabinose, and sorbit, acid and gas are produced, while no action occurs on lactose, cane-sugar, inulin, amygdalin, salicin, raffinose or erythrit. He states that the indol reaction is variable, but more often found in b. paratyphoid and b. aertryck than in b. Gaertner, and says that on two occasions b. paratyphosus Schottmüller A, and also the Brion and Kayser strain, showed strong alkalinity on milk after two months. He gives notes of two atypical paratyphoid organisms which gave strong acidity on milk, acid and gas on salicin, otherwise resembling the Gaertner type organisms.

MacConkey (1906)[7] describing the organism associated with an outbreak of food poisoning at Fulham, isolated from the spleen of a child and the hind limb of a rabbit, says that it corresponded in every way with those of b. enteritidis (Gaertner) group, and notes that acid and gas were produced on glucose, mannose, maltose, arabinose, raffinose, mannit, dulcit, sorbit and dextrin. (He notes reasons for the unreliability of the raffinose test). No action took place on lactose, cane-sugar, adonit, erythrit, inulin.

MacConkey states that b. L. Hume ferments adonit with the production of acid and gas. (A similar organism is later noted by the author).

Savage and Gunsen (1908)[8] describing an outbreak of food poisoning due to infected brawn, discovered a bacillus which they finally agreed to place in the Aertryck branch of the Gaertner group. It produced acid and gas on glucose, mannit, dulcit, and maltose, but showed no action on lactose, saccharose or salicin. Litmus milk was turned acid and later alkaline.

Bainbridge (1909)[9c] finds that b. paratyphoid B., b. Danysz, b. suipestifer, b. Gaertner, and b. typhi murium are culturally indistinguishable, and notes the formation by them of acid and gas on glucose, mannit, dulcit, maltose, galactose, and arabinose, while without action on lactose, saccharose, raffinose, salicin or inulin.

He makes the observation that one strain of suipestifer never produced gas on any media, and concludes on rather inadequate grounds that this was a variant form. In Table IX are shown a number of this type of organism, as tested by myself in this laboratory, from widely different sources. It is evident that the organism whatever be its relation to the Gaertner group is a well defined type.

May (1911)[35] isolated a paratyphoid type organism from water. He found that on glucose, mannit and galactose, acid and gas were produced. On dulcit and maltose, acid only was produced; no action occurred on lactose, saccharose, dextrin or glycerin.

McWeeney (1911)[10] describing the characteristics of food poisoning organisms, after noting the fermentation of glucose and dulcit with the production of acid and gas, and the fact that lactose is not attacked, says that besides showing cameleonage on litmus milk, they gradually "clear up" ordinary milk. This I will refer to later.

Summary of results of the above observers.

Glucose,	tested by	all	observers	... ...	acid and gas
Lactose,	,,	,,	,,	... ...	nil
Mannit	,,	14	,,	... ...	acid and gas
Saccharose	,,	12	,,	... ...	nil
	,,	Gwyn		... ...	slight action
Maltose	,,	7	,,	... ...	acid and gas
	,,	May	,,	... ...	acid alone
Dulcit	,,	7	,,	... ...	acid and gas
	,,	MacConkey for hog cholera Smith, nil.			

Galactose	tested by	5	observers	acid and gas
Inulin	,,	5	,, ...	nil
Levulose	,,	5	,, ...	acid and gas
Raffinose	,,	3	,, ...	nil
	,,	MacConkey	... ...	acid and gas
Dextrin	,,	3	observers	acid and gas
	,,	May	... ...	nil
Arabinose	,,	3	observers	acid and gas
Salicin	,,	3	,, ...	nil
Erythrit	,,	3	,, ...	nil
Sorbit	,,	2	,, ...	acid and gas
Amygdalin	,,	1	,, ...	nil
Glycerin	,,	1	,, ...	slight action

Litmus milk, or litmus whey, was used by the majority of the above observers and the results are in agreement. Acidity is always produced followed quickly by alkalinity in one group. In the other group the acidity is either permanent or much more slowly replaced by alkali. The indol reaction seems to have given rather variable results.

Present Investigations.

The present investigation is firstly the outcome of an inquiry into the bio-chemical properties as tested by the various media detailed in tabular form of the Gaertner type organisms stocked in the Bureau, which have either come into our possession as "standard types" from various European laboratories, or been collected from various sources as part of the work of this department. Later in this communication I give the results of the bio-chemical findings in certain organisms isolated under my direction from samples of normal human faeces, food stuffs, etc., which approximately belong to the Gaertner type. Finally I conclude with some findings in connection with certain cultures of the anaerogene class which was found in our stock labelled incorrectly.

Technique.—For all "sugar" tests 1% litmus peptone water containing the various sugars ½% strength was used, except in the case of glucose, mannit, lactose and cane-sugar, where 1% strength was substituted. The solutions were put up in test tubes with Durham's gas collecting tubes. All sugars are from Merck, except saccharose, which is ordinary brewers' crystals.

The results following are made up from the notes of nearly a year's work, during which time the majority of the tests have been applied at least twice.

In Table I. are displayed the bio-chemical reactions of thirteen cultures from European laboratories labelled paratyphosus or paracolon. This table incidentally shows the media used and the general method adopted.

The reactions of the various "sugar" media are identical in quality, though variable to some extent in quantity. Thus there is some variation in the time taken to ferment dulcit, some cultures giving acid and gas on this sugar in twenty-four hours, others taking several days. But as considerable variations occurred in individual tests of certain organisms, it was not thought advantageous to rely much on this characteristic. All, however, are able to ferment dulcit within four days.

A similar but less marked irregularity is found with maltose, galactose and arabinose. As regards morphology, motility, and growth on agar, I do not wish to dwell, except to say that I have found no useful distinguishing properties by these tests.

Litmus milk is usually regarded as a valuable means of separating two types of b. paratyphosus, A and B. Type A being said to give slight permanent acidity, Type B, "Cameleonage" or acid followed by alkaline reaction; but it will be seen that there are several variations in the type

Table I.—*Showing the reactions of 14 Paratyphoid and Paracolon Cultures from European Laboratories.*

Register Number.	Morph.	Gram.	Gelatine. 21 days.	LITMUS MILK. 1 day.	3 days.	7 days.	15 days.	21 days.	28 days.	All positive results shown occurred before the 4th day unless otherwise marked. All negative results shown were observed up to 3 weeks. Glucose.	Mannit.	Dulcit.	Lactose.	Saccharose.	Maltose.	Dextrin.	Galactose.	Inulin.	Amygdalin.	Salicin.	Arabinose.	Raffinose.	Sorbit.	Erythrit.	Adonit.	Indol. 7 days.	Labelling of Culture.
1	smb	–	–	a	a	.	.	–?	.	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	sl	B. paratyph. Coleman and Buxton Kral, 1906.
2	smb	–	–	a	a	a	a	...	–	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	sl	B. paratyph. Hewlett Kral 1906.
11	smb	–	–	a	a	alk	ALK	ALK	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paratyph. (A) Schottmüller Kral 1906.
3	mb	–	–	a	a	a	–	.	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	sl	B, paratyph. (A) Brion and Kayser Kral 1906.
6	smb	-	–	–	a	a	.	–?	.	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paratyph. (A) Lentz 1911.
13	smb	–	–	a	a	a	–	.	alk	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paratyph. (A) Schottmüller L.I.P.M. 1911.
12	smb	–	–	a	a	alk	ALK	.	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paratyph. (B) Schottmüller Kral 1906.
42	mb	-	–	a	–	ALK	ALK	.	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paratyph. (B) Brion and Kayser Kral 1906.
60	smb	–	–	a?	–	alk	ALK	.	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paratyph. (B) Lentz 1911.
68	mb	–	–	a?	a	–	ALK	.	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	–	B. paratyph. (B) Schottmüller L.I.P.M. 1911.
69	mb	–	–	a?	a?	alk	ALK	.	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paratyph. (B) McWeeney L.I.P.M. 1911.
4	smb	–	–	a	a	a	–	–	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	sl	B. paracoli Allen Kral 1906.
5	mb	–	–	a	a	a	.	ALK	.	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paracoli Gwyn Kral 1906.
66	smb	–	–	a	alk?	ALK	ALK	.	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. paracoli Strong Kral 1906.

Explanation.—mb = motile bacillus; smb = slightly motile bacillus; a = slight acid; AG = acid and gas; alk = slight alkalinity; ALK = marked alikalnity; sl = slight; tr = trace; – = negative or no action.

of action on milk, some showing a long continued slight acidity gradually becoming less, and probably, if left long enough, eventually producing alkalinity, others more rapidly produce strong alkalinity, while between the extreme types are found several varieties.

The indol reaction tested by the nitrite and sulphuric acid method varies considerably, but my own experience shows that this method of testing is unreliable. It has been possible since these tables were drawn up to procure the reagents for the benzaldehyde test.[42] All the Gaertner type organisms referred to in Table I. were tested by it, but *none of them gave positive indol reactions.*

The following cultures were tested in the same manner:

B. *Food Poisoning Type.*

P. 54	Gaertner	Institut Pasteur
P. 55	Gaertner	Kral 1902
P. 53	Gaertner	Kral 1904
P. 29	Gaertner	Lentz 1911
51	Abel	Kral 1906
56	Breslaviensis	Kral
57	Moorseele	Kral
61	Gunther	Kral
65	Hanstedt	Kral 1906
67	Renfleth	Kral 1906
70	Aertryck	L.I.P.M. 1911

C. *Rat Virus Type.*

P 46	Danysz 1904
P 47	Danysz from Danysz Virus Co., 1904
P 72	Danysz from Liverpool Institute 1904
P 48	Danysz from Dr. Danysz 1906
P 44	From "Azoa" (P.D. & Co.) (Bur.) 1907
P 63	From "Azoa" (P.D. & Co.) (Bur.) 1910
P 45	From Ratin (Ratin Virus Co.) (Bur.) 1907

D. *Swine Diseases.*

P 22	Swine fever	L.I.P.M.
P 23	Hog cholera	French
P 24	Hog cholera	Klein
P 25	Swine fever	Gilruth

E. *Miscellaneous.*

P 40	Typhi murium	Ray I.P.
P 49	Psittacosis	I.P.
P 50	Psittacosis	Kral 1902
P 52	Morbif bovis	Kral

As regards the reactions of the food poisoning, rat virus, and miscellaneous types above described, the vast majority show no marked variation from the B. type paratyphoid bacilli shown in the table.

Numbers P_{61} (b. Gunther Kral.), P_{47} (b. Danysz from Danysz Virus Co.) gave slight acidity on salicin after a week. Numbers P_{29} (b. Gaertner Lenz), P_5 (b. Abel Kral), P_{65} (b. Hanstedt Kral), P_{67} (b. Renfleth Kral) showed late action on arabinose. This was not affected till after a week (between 7 and 21 days). There were also irregular differences in the amount of motility displayed and in the exact rate of alkalinisation of the litmus milk.

The indol reaction in all cases was negative by the benzaldehyde method though frequently there was shown a trace of colour by the sulphuric and nitrite method.

The swine fever cultures while agreeing with the remainder in all other respects *never affected arabinose during the three weeks period of observation.* Also it may be added none of these four cultures attacked dulcit under four days, one strain taking over a week (between 7 and 21 days).

Table II. shows the biological characteristics of fifteen organisms isolated at the Bureau and provisionally classified

Table II.—*Showing the reactions of 13 locally isolated Gaertner Type Cultures.*

No.	Morph.	Gram.	Gelatine.	Litmus Milk. 1 day.	3 days.	7 days.	15 days.	21 days.	28 days.	Glucose.	Mannit.	Dulcit.	Lactose.	Saccharose.	Maltose.	Dextrin.	Galactose.	Inulin.	Amygdalin.	Salicin.	Arabinose.	Raffinose.	Sorbit.	Erythrit.	Adonit.	Indol.	Labelling of Culture.	
										All positive results shown occurred before the fourth day unless otherwise marked. All negative results shown were observed up to three weeks.																		
P_7	smb	–	–	a	a	alk	ALK	ALK	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. from milk (Bur) 1903.	I.
P_{28}	smb	–	–	a	a	alk	ALK	...	A	AG	AG	–	–	a^7	AG	–	AG	–	–	ag^7	AG	–	AG	–	–	tr	B. from corned beef (Bur) 1906.	I.
P_{58}	mb	–	–	a	a	alk	ALK	...	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	a^7	AG	–	AG	–	–	tr	B. from brawn (Bur) 1909.	I.
P_{62}	mb	–	–	a	–?	alk	ALK	...	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	–	B. from case "ptomaine" (Bur) 1911.	I.
P_{18}	smb	–	–	a	–	alk	ALK	ALK	ALK	AG	AG	–	–	–	AG	–	AG	–	–	–	–	–	AG	–	–	tr	B. swine fever (Bur) 1909,	II.
P_{19}	smb	–	–	a	–	alk	ALK	ALK	ALK	AG	AG	–?	–	–	AG	–	AG	–	–	–	–	–	AG	–	–	tr	B. from glands pig (Bur) 1910.	II.
P_{64}	mb	–	–	a	...	...	...	...	...	AG	AG	AG^7	–	–	AG	–	AG	–	–	–	–	–	AG	–	–	–	B. from glands pig (Bur) 1910.	II.
P_{21}	smb	–	–	a	–?	alk	ALK	...	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	–	–	AG	–	–	–	B. swine fever Rookwood (Bur) 1910.	II.
P_{25}	mb	–	–	a	–	alk	ALK	...	ALK	AG	AG	AG^5	–	–	AG	–	AG	–	–	–	–	–	AG	–	–	tr	B. swine fever Sydney (Bur) 1905.	II.
P_{26}	mb	–	–	a	–	alk	ALK	...	ALK	AG	AG	AG^7	–	–	AG	–	AG	–	–	–	–	–	AG	–	–	tr	B. swine fever Sydney (Bur).	II.
P_{43}	mb	–	–	a	–	alk	ALK	...	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	tr	B. calf Broughton Island (Bur) 1907.	III.
P_{59}	mb	–	–	a	–?	alk	ALK	...	ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	–	B. ourang outang (Bur) 1910.	III.
P_{41}	mb	–	–	a	a	alk	ALK		ALK	AG	AG	AG	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	–	B. canary (Bur).	III.

The numbers after the reaction letters indicate approximately the date of first sign of action.

as Grertner type. With the doubtful exception P_{28}, which slowly ferments saccharose, they are undoubtedly to be included under that heading. Two cultures P_{28} and P_{58}, slowly and slightly affect salicin.

With regard to Sections I. and III. of this table, no comment is necessary, but Section II. showing the reactions of locally isolated organisms from swine gives confirmatory evidence to the facts mentioned above. *Again none of these "swine fever" organisms ferment arabinose, and again the hesitancy to act upon dulcit is marked.*

It is interesting to note that no other organism out of the cultures tested except those isolated from swine failed to ferment arabinose.

Glycerine and Sodium formate.

I have made some experiments to determine whether the action of Gaertner type organisms on glycerine or sodium formate would be of any value as means of differentiation, but although both of these substances are acted upon by numerous strains the action is slow and uncertain. On glycerine, acid is produced by the majority of the strains tested, generally there is no gas formation apparent, but sometimes also a little is formed. On sodium formate at times no action occurs while at other times gas is produced. The reason for the irregularity of the action of these substances is by no means apparent.

Clearing of Milk.

I have tested the observation that milk is gradually cleared by the Gaertner type cultures and have come to conclusions practically identical with McWeeney. This change cannot be perceived well on the litmus milk media, and so I inoculated with all the European and locally isolated Gaertner type cultures described, plain sterilised milk tubes. At the end of a month the change is clearly perceptible, the great majority of the Gaertner group show

this reaction very definitely. Compared with a non-inoculated tube of milk, or better with a tube clotted by the action of b. coli, there is seen to be a distinct lessening of opacity, but as mentioned before, no obvious peptonisation as is seen in many of the proteus and other gelatin liquefiers. This reaction owing to the time taken to manifest itself, cannot, however, be considered of much practical use.

A few cultures did not show the reaction, but these are, as one might expect, only found amongst those which produce the alkaline reaction slowly, probably if left longer they too would show the change.

This characteristic of the Gaertner group, which is a very fundamental one, has been noticed by comparatively few observers (19, 10). It is probably due to a slow proteolytic action of the bacillus upon the "membranes" of proteid between the fat globules which are liberated and rise to the top.

Conclusions.

1. The bio-chemical characteristics of forty "standard" (type Gaertner) cultures principally from European laboratories have been systematically tested, using a large number of "sugars," milk, and litmus milk.

2. There is a very close similarity in the bio-chemical characteristics of the members of the group though fairly wide individual variations in degree exist.

3. On glucose, mannit, maltose, galactose and sorbit, acid and gas are rapidly produced usually within forty-eight hours, always before five days.

4. On lactose, saccharose, dextrin, inulin, amygdalin, raffinose, adonit and erythrit, no action is produced by any of the strains incubated up to three weeks.

5. On dulcit, acid and gas is produced by all the strains, but the time taken is usually longer than with the other sugars, and is especially long in the hog cholera group.

6. On arabinose, acid and gas is produced by all but the hog cholera type, generally under four days, but certain of the food poisoning group took longer—over a week to do that. *The hog cholera cultures do not attack arabinose under twenty-one days.*

7. Salicin is rendered slightly acid by three cultures; by the rest it is unaffected up to three weeks.

8. The Gaertner group produce on litmus a transient and often very feeble acidity, followed later by a reversal of the process generally shown by marked alkalinity. The subdivision into A and B types is one of degree, and cannot be strictly maintained bio-chemically as linking types are found between the extremes, but may be of interest in tracing the relationship of various strains of Gaertner type, pseudo-Gaertner and other colon bacilli.

9. Ordinary milk is after a month perceptibly cleared by the vast majority of Gaertner type strains. There is a close relationship between the degree of alkali formation and the "clearing."

10. The indol reaction tested on the seventh day in peptone water by the sulphuric acid and nitrite method is variable, but never more than slight. This test is unreliable. No indol can be demonstrated by the benzaldehyde method under identical conditions.

11. Morphology, motility, growth on gelatin agar or potato are of no assistance whatever in the grouping of these organisms.

12. Fourteen stock cultures isolated at the Bureau from local sources and tested in the same way as the European series, give results generally speaking confirmatory of the above, except that one culture from a food poisoning epidemic slowly affected saccharose. Salicin was attacked slowly by this, and by another culture from a food poison-

ing epidemic. Arabinose was attacked by *all of this series except the swine disease cultures*, thus confirming the fact noted before, that such strains do not affect this sugar, and that this may be used as a means of differentiation. The action on dulcit on certain of the Bureau strains, however, showed wider variations, for in two swine fever cultures and in one food poisoning culture, no action occurred up to three weeks.

The result of the above tests is in agreement with previous observers with two noteworthy exceptions. Whereas I find arabinose is unaffected by old cultures from swine, Bainbridge states that acid and gas are formed on this sugar. I do not think there is any possibility of error of observation on my part as the results have been repeated more than once. The only alternatives are firstly that my arabinose is not the same as Bainbridge's (mine is from Merck), secondly that he has in the preparation of his arabinose media somehow facilitated the breaking down of it by the strains used. In the preparation of my sugar media, the ordinary steam sterilisation (twice for half hour) is used, and the media is neutral, so breaking up is out of the question. Again, none of my Gaertner types affect dextrin, while three observers above quoted, found that acid and gas is produced. The above remarks *re* arabinose apply equally well to dextrin.

Notes on certain recently discovered Pseudo-Gaertner type organisms recovered from various sources.

(See Table III.)

Case I. Purcell.—This organism was recovered from the blood of a septicaemic case, the history of which is as follows:—The patient was operated upon for epithelioma of lip and neck glands; these removed, he was progressing to recovery when suddenly the temperature shot up and the pulse became very quick. An erysipelatous condition

Table III.

No.	Morph.	Gram.	LITMUS MILK. 1 day.	LITMUS MILK. 3 days.	LITMUS MILK. 7 days.	Glucose.	Mannit.	Dulcit.	Lactose.	Saccharose.	Maltose.	Dextrin.	Galactose.	Inulin.	Amygdalin.	Salicin.	Arabinose.	Raffinose.	Sorbit.	Erythrit.	Adonit.	Indol. 7 days.‡	Labelling of Culture.
						All positive results shown occurred before the fourth day unless otherwise marked. All negative results shown were observed up to three weeks.																	
8789	b	–	a	alk	alk	AG	AG	–G	–	–	AG	–	AG	–	–	AG	AG	–	AG	–	–	+	Fæces.
Caton	b	–	a	ALK	ALK	AG	AG	–	–	–	AG	–	AG	–	–	AG	AG	–	AG	–	–	+	Fæces (normal).
Pennington	b	–	a	–	ALK	AG	AG	–	a^{18}	–	AG	–	AG	–	–	–	–	–	–	–	–	+	Fæces (normal).
3511	b	–	a	–	ALK	AG	AG	–	a^{18}	A^{18}	AG	–	AG	–	–	–	–	–	–	–	–	+	Ice cream.
Purcell	b	–	a	alk	ALK	AG	AG	AG^{7}	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	–	Blood case of Streptococcic septicaemia.
*Levenberg	b	–	a	AC	AC	AG	AG	AG	A^{6}	–	AG	–	AG	–	–	AG	AG	–	AG	–	–	+	Fæces (normal).
*McMillan	b	–	a	A	AC	AG	AG	AG^{5}	AG^{5}	AG^{5}	AG	–	AG	–	–	–	AG	–	AG	–	–	+	Fæces (normal).
*Iggulden	b	–	a	A	AC	AG	AG	AG	AG^{3}	–	AG	–	AG	AG	–	a	AG	AG	AG	–	–	+	Fæces (normal).
*3202 (11)	b	–	a	A	AC	AG	AG	AG	A^{3}	–	AG	–	AG	–	–	AG	–	–	–	–	AG	+	Fæces (intestinal infection).
†9658	b	–	a	–	alk	AG	AG	–	–	–	AG	–	AG	–	–	–	AG	–	AG	–	–	+	Fæces (suspect typhoid carrier).

* These four are quite obviously not Gaertner type, but are shown to demonstrate the fallacy of reading the sugar reactions too early.

† This culture had only been tested one week when this table was made up. ‡ Indol tested by benzaldehyde method.

developed in head, neck, and spread to trunk (not on arms). About forty-eight hours after the onset, streptococci were recovered from blood. Three days later, from a blood culture taken in the same way as before, no streptococci were found but staphylococci and the bacillus now under discussion. Two days later the blood was sterile. The patient was treated with an autogenous vaccine of streptococci from which he seemed to derive much benefit. I am inclined to think the Gaertner type bacillus may have been a secondary invader in the lowered condition, which was quickly killed off as the patient progressed to improvement. It gives all the reactions of a typical Gaertner type organism, including a negative indol reaction tested by the benzaldehyde method on the eighth day.

Case II. (8789).—In faeces from a patient in hospital, condition unknown, but as far as I can find out not typhoid, paratyphoid or food poisoning, a Gaertner type organism was found giving the typical cameleonage on litmus milk, and not affecting lactose or cane sugar, and giving acid and gas on glucose, mannit and dulcit. The fermentation of salicin on the third day should be noted. The indol reaction (benzaldehyde method) was strongly positive in seven days.

Case III. (Caton).—This organism was recovered from the faeces of a healthy man on a ship on which there had been several cases of true enteric fever. It is distinguishable from the Gaertner type in that on salicin acid and gas are produced, also dulcit and arabinose are not attacked up to twenty-one days. The indol reaction was strongly positive after a week's incubation (benzalehyde method).

Case IV. (Pennington).—This organism was recovered from the faeces of a healthy man on the same ship. At a week's incubation it is indistinguishable from a true Gaertner type organism. By twenty-one days dulcit and

arabinose were not affected, and on lactose a trace of acid was produced. The indol reaction (benzaldehyde method) was strongly positive in seven days.

Case V. (Levinberg).—This organism was recovered from the faeces of a healthy man on the same ship. At two days' incubation it was indistinguishable from a true Gaertner type organism, but by a week on lactose acid was produced, and on salicin acid and gas. The litmus milk by this time had clotted. The indol reaction (benzaldehyde method) was strongly positive in seven days.

Case VI. (McMillan).—This organism was recovered from a healthy man on the same ship. At three days incubation it was only distinguishable from a true Gaertner type organism by the strong acidity on milk. At a week, however, the lactose and cane sugar tubes showed small amounts of acid and gas. The indol reaction (benzaldehyde method) was strongly positive in seven days.

Case VII. (3202).—In the faeces of a case of intestinal infection firstly diagnosed as typhoid, but subsequently clearly showing itself a quite different condition, was isolated amongst other organisms a gram negative colon-like bacillus. This tested, gave reactions closely akin to b. paratyphosus A. Milk was acidified slightly at first, later becoming strongly acid. At forty-eight hours the only difference from b. paratyphosus A. was that on adonit acid and gas were produced, while sorbit was not affected. Later the lactose tube became acid, and gas was not produced up to twenty-one days. The indol reaction (benzaldehyde method) was strongly positive in seven days.

Case VIII. (3511).—From ice cream, an organism agreeing with the Gaertner type in many particulars. Dulcit and arabinose were not fermented. The organism between the eighteenth and twenty-first day gave slight acid on lactose and cane-sugar. Litmus milk shows cameleonage.

The indol reaction (benzaldehyde method) was strongly positive in seven days.

It will be noted that only one of these organisms is quite typical in its reactions as compared with the previous tabulated results of standard types or cultures isolated from sources where infection with some of the recognised types might be presumed.

All of these "pseudo-gaertner" except Case I. gave a strong positive indol reaction. Four of them though at first non-lactose fermenters, attack this sugar within a week and clot milk. Two others attack lactose very slowly though giving typical cameleonage on litmus milk. Two others ferment salicin energetically and early.

Notes on Certain Anaerogenes.

The last Table No. IV. shows the biochemical reactions of certain anaerogene organisms labelled suipestifer and fowl cholera. They are of interest as being closely similar to the strain found by Bainbridge which he assumed was a variant Gaertner type.

The principal resemblance to this type is the cameleonage of milk and the non-fermentation of lactose.

Table IV.—*Showing bio-chemical reactions up to one week of anaerogene strains of Suipestifer-Fowl Cholera, etc.*

No.	8 Gelatine.	Litmus Milk. 1 day.	7 days.	3 days.	Glucose.	Mannit.	Dulcit.	Lactose.	Cane sugar.	Maltose.	Dextrin.	Galactose.	Inulin.	Amygdalin.	Salicin.	Arabinose.	Raffinose.	Sorbit.	Erythrit.	Inosit.	Adonit.	Labelling of Culture.
A41	–	a	–	alk	A	A	A	–	–	A	–	A	–	–	–	A	–	.	–	.	–	Suipestifer, Kral.
A30	...	a	–	alk	A	A	A	–	–	A	–	A	–	–	–	–	–	.	–	.	–	Suipestifer, Botany.
A36	..	a	alk	alk	A	A	A	–	–	A	–	A	–	–	–	A	–	.	–	.	–	Cholera suum, Kral.
A49	...	a	–	–	A	A	A	–	–	A	–	A	–	–	–	.	–	.	–	.	–	Fowl cholera, Sydney
A48	–	a	–	–	A	A	A	–	–	A	–	A	–	–	–	A	–	.	–	.	–	Fowl cholera, French
A47	–	a	–	–	A	A	A	–	–	A	–	A	–	–	–	A	–	.	–	.	–	Fowl cholera, Klein.

Final Conclusions.

I. No definite bio-chemical distinction can be drawn between b. paratyphosus (B), b. enteritidis Gaertner (or the other food poisoning strains), the rat virus bacilli, b. typhi murium, b. psittacosis or b. morbif bovis.

II. The bio-chemical distinction between b. paratyphosus A, and b. paratyphosus B, is one of degree only.

III. *The Gaertner type organisms from swine are separable from the other Gaertner strains by their inability to attack arabinose.*

IV. The action on dulcit of a number of the Gaertner type cultures shows considerable variations, and dulcit therefore cannot be considered of much value in differentiation.

V. Salicin is only exceptionally attacked by any of the above strains. A trace of action occurred in one rat virus strain and in two locally isolated food poisoning strains, but occurring late may possibly be due to accidental contamination.

VI. From a number of sources where infection with Gaertner type organisms was not likely, *i.e.* normal faeces and in one ice-cream, Gaertner-like organisms were found, but in every case could be differentiated bio-chemically from the true type. These pseudo-gaertners may or may not ferment salicin, which is therefore not an absolutely reliable differential test. Lactose and cane-sugar are sometimes affected late, but in some cases the indol (benzaldehyde) reaction, which is always positive in strong contrast to the invariable negative result with the true Gaertner types, was the sole distinguishing feature.

VII. In the blood of a case of erysipelatous septicaemia after wound infection, an organism bio-chemically indistinguishable from the true Gaertner type was detected.

VIII. Two cultures labelled suipestifer, one culture labelled cholera, and three cultures labelled fowl cholera, were found to be non-gas formers, approximating closely to Bainbridge's variant form. The most simple conclusion is that as these stains are quite easily mistaken for Gaertner type, unless gas formation is noted, that this error has been made by several observers. They are evidently a definite enough type and widespread in distribution in pigs and fowls. Whether of any pathological significance cannot be said.

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ON A NEW SPECIES OF PROSTANTHERA AND ITS ESSENTIAL OIL.

By R. T. BAKER, F.L.S., and H. G. SMITH, F.C.S.

With Plate I.

[*Read before the Royal Society of N. S. Wales, July 3, 1912.*]

Introduction.

THE genus *Prostanthera* is endemic to Australia, and comprises some fifty species, a few new ones having been described in recent years. They form a very distinct group of the natural order Labiatæ, and are distinguished in the bush by their aromatic flowers and leaves.

The presence of oil in their leaves has long been known, and Bosisto, as far back as 1862, distilled oil from *P. lasianthos* and *P. rotundifolia*. The latter species yielded 0·75 per cent. of oil; the former very much less. No constituent, however, was indicated, and, so far as we are aware, the constituents common to the oils of the Prostantheras have not previously been determined. The isolation of cuminaldehyde is perhaps of some importance for diagnostic purposes, as it does not appear to have been previously isolated from the oil of any member of the Labiatæ. Cineol is not uncommon in the oils of the group, and the phenols thymol and carvacrol often occur.

The Prostanthera, the subject of this paper, was received at the Technological Museum in October 1908, having been forwarded by Mr. B. Howitz of the Imperial Hotel, Singleton. He sent later 20℔s. of the material for distillation. The amount of oil distilled from this was altogether too small for complete investigation, but it was shown to

have a high specific gravity, and to contain much cineol. In March of this year a quantity of this plant was forwarded to the Museum, by Mr. C. H. Cheesbrough of Siberia, Broke, near Singleton, N. S. Wales, through the Director of Forests of this State; from this sufficient oil was distilled for the purpose of investigation. Mr. Howitz in his letter suggested that the oil might be found to be similar to cajuput, which, as the result showed, was not a bad suggestion. The Museum Collector had also forwarded botanical material of this species from Millfield in 1908.

In the district where this Prostanthera grows plentifully, it is considered as having some medicinal value, and when the leaves are crushed and the vapour inhaled, acts as a specific against influenza and similar complaints. The plant is also said to be objectionable to flies. These properties suggest that the active principle lies in the essential oil, but from the composition of this, it is hardly to be expected that it could be much more efficaceous than an ordinary eucalyptus oil of the eucalyptol-pinene class, and that whatever medicinal value it may have, is primarily due to the cineol (eucalyptol) in the oil, no less than 61 per cent. of the crude oil being that constituent. The oil also contains a small quantity of carvacrol with a trace of thymol, but hardly in sufficient quantity to be of much value medicinally, although both thymol and carvacrol—closely related phenols—have considerable antiseptic value. Other constituents occurring in this oil are cuminaldehyde, pinene, cymene, a sesquiterpene, geranylacetate, together with a small quantity of another ester, some free geraniol and a small amount of an undetermined alcohol.

The specific name *cineolifera* is now proposed for this species in allusion to the large amount of cineol contained in the essential oil of its leaves.

Systematic Botany.

Prostanthera cineolifera, sp. nov.

A leafy shrub, several feet in height, stems and branchlets hoary pubescent, foliage glabrous. Leaves, mostly about an inch long but in a few cases two inches, lanceolate, entire, flat, pale and punctate on the under side, dark green above with a few white scales, up to half an inch broad. Flowers in terminal racemes, distant, opposite in slender pedicels, about two inches long. Pedicels longer than the calyx with minute bracts removed from the calyx. Calyx under two lines long, tube striate, the lower lip longer than the upper, glabrous with a few white scales. Corolla slightly pubescent on the inside, but glabrous internally, twice the length of the calyx, the upper lobes rather shorter and smaller than the lateral ones, all acuminate, the lower lip twice the size of the lateral and lobed, with edges slightly crenate. Anther without appendages or very minute.

[Frutex altitudinem 7′ to 8′ attinens. Floribus paniculatibus terminalibus. Ramuli cani. Folia plana glabra, lanceolata, infra punctata et pallida, 1″ – 2″ longa. Bracteolae minutuae. Calyces 2‴ longi, labiis fere aequilongis, et pedicellis 2‴ longis. Corolla 4‴ longa alba, labio infero bifidato, superum bis excedente, lobis laterabilis et dorsalis acuminatis, stamina non ultra facem extendentia. Antheræ sine appendicibus. Stylus apice breviter bifidus.]

Habitat.—Singleton (Howitz). Siberia, Broke, (C. H. Cheesebrough). Cedar Creek, Millfield (C. F. Laseron).

Remarks.—This species belongs to the racemosæ group of Prostanthera, a section of the genus established by Bentham in his Flora of Australia, Vol. v, p. 91, and of the species so recorded this one appears to be quite distinct in foliage, inflorescence and other characters.

Bentham divides this section into groups according to the size of the leaf *i.e.*, those mostly above one inch, and

those under this measurement. In such a classification, this plant falls into the first group, in which are found *P. lasianthos*, *P. prunelloides*, *P. coerulea*, *P. melissifolia*.

From *P. lasianthos* it differs in the absence of serrations in the leaf, in the calyx, corolla and in other appendages.

From *P. prunelloides* and *P. coerulea* in the stripe, colour, size of leaves, altogether apart from any inflorescence distinctions, and for the matter of that, *P. ovalifolia* as well.

P. melissifolia has a distinct foliage and flower from this species. Systematically it might be placed between *P. ovalifolia*, from which species however it differs in shape and size of leaf, and inflorescence, and *P. discolor*, R. T. B., in shape of leaf. Its leaves are quite distinct in shape from any species known to us. It has no affinity with the species *P. granitica* and *P. teretifolia* recently described by Maiden and Betche, Proc. Linn. Soc., Vols. for 1905 and 1908 respectively.

Essential Oil.

The material for distillation was collected in March 1912. It was quite green when received, and consisted mostly of stalks, about two feet long, with leaves attached. The yield of oil was equal to 0·71 per cent., 270 lbs. of leaves and branchlets giving $30\frac{1}{2}$ ounces of oil. The crude oil was yellowish in colour when freshly distilled, but this soon altered in the light, becoming considerably darker after forty-eight hours; this darkening was evidently due to the presence of the phenols.

The odour was not distinctive, although that of cineol was readily detected. The oil was somewhat mobile and readily soluble in alcohol. When two or three drops of the oil were heated with an equal weight of potash, and twenty drops of chloroform, the colour reaction for carvacrol or

thymol was obtained. The crude oil gave the following results:—Specific gravity at 15° C. = 0·9204. Refractive index at 22° C. = 1·4711. Soluble in 1·7 volumes 70 per cent. alcohol (by weight). The colour of the oil was too dark to allow the light to pass, and as phenols were present the ester determinations and the rotation were made with the oil from which these, and the aldehyde, had been removed. This cleared oil had the following characters:—Specific gravity at 15° C. = 0·9199. Rotation $a_D = +4°·1$. Refractive index at 22° = 1·4706. Saponification number of ester + free acid = 9·9 by boiling, and 8·5 by cold saponification with two hours contact.

Esterised oil.—A quantity of the cleared oil was boiled with acetic anhydride and anhydrous acetate of soda in the usual way, separated, and washed until neutral. The oil had altered little in appearance, but was more aromatic, reminding one strongly of geranyl-acetate. The saponification number of the esterised oil by boiling had increased to 34·2 and by cold saponification to 18·3. It is thus probable that the principal ester in the oil of this plant is geranyl-acetate, and that a portion of free geraniol is also present. This was indicated by the marked odour of geranyl-acetate in the esterised oil, the secondary odour of geraniol in the saponified oil, and the results of cold saponification. It was not feasible to separate the pure geraniol, as it was only present in small amount, and the oil available was not sufficient for the purpose, but we have now separated geraniol from so many Australian essential oils in a pure condition, (even from the pine-needle oils of the Callitris), that we have little doubt that the principal ester in this Prostanthera oil is geranyl-acetate. The amount of this ester in the esterised oil was equal to 6·4 per cent., and as the whole ester formed was only 11·9 per cent., taking the molecule as $C_{10}H_{17}OH$, more than half was geranyl-

acetate. The amount of geranyl-acetate in the crude oil was 2·9 per cent. The volatile acid was separated from the high boiling fraction and from the residue and proved to be acetic. There is also an undetermined alcohol present both in the free condition and as an ester, but it was not separated and its identity is thus undetermined.

The Phenols.—250 cc. of oil (230 grams) were agitated with 5 per cent. aqueous potash until the phenols were dissolved, the aqueous portion was separated, shaken out with ether to remove adhering oil, and acidified. The separated phenols were removed with ether and evaporated to constant weight. The total weight of the phenols was 1·492 gram. equal to 0·65 per cent. The phenol was liquid, had the appearance and odour of carvacrol, and gave the reactions required for that substance. After some weeks it was still a thick liquid, although the thinner portions showed signs of crystallisation. These crystals were added to the liquid phenol, and after about another week, crystals had formed in the mass. It is thus shown that both thymol and carvacrol are present in the oil of this Prostanthera. These phenols are frequently found in the oils of members of the Labiatæ.

The Aldehyde.—The oil, after the removal of the phenols, was well washed and treated for some hours with an almost saturated solution of sodium bisulphite, with repeated agitation. A little solid formed, this was filtered off, well washed with ether-alcohol and dried on a porous slab. It was then decomposed by heating with carbonate of soda, extracted with ether, and the aldehyde evaporated to constant weight. It weighed 0·326 gram. equal to 0·142 per cent. Nothing was obtained from the decomposition of the aqueous portion. The aldehyde was liquid, slightly tinged yellow, and had the odour of cuminaldehyde, or of aromadendral, (the aldehyde of some Eucalyptus oils). As only

such a small quantity was available it was decided to form the phenylhydrazone. This was prepared without difficulty, and after purification melted sharply at 126 – 127°. This result, taken with the other factors, shows the aldehyde to be cuminaldehyde.

This aldehyde, together with the carvacrol, causes the oil to have a peculiar odour, but when these are removed the odour is that of a Eucalyptus oil of the eucalyptol-pinene class.

Redistillation.—125 cc. of the cleared oil were taken, only a few drops of acid water and a little volatile aldehyde came over below 135° C., the temperature then quickly rose to 167° (temps. corr.). Between 167 – 172° 40 per cent. distilled; between 172 – 204° 46 per cent.; between 214 – 224° 2·5 per cent. The specific gravity at 15° C. of the first fraction = 0·9063; of the second = 0·9174; and of the third = 0·9321. The rotation of the first fraction a_D = + 3°·7; of the second + 1°·9. The refractive index at 19° C. of the first fraction = 1·4661; of the second = 1·4688; and of the third = 1·4901.

The cineol was determined in the first two fractions by the resorcinol method, the mean of two closely agreeing determinations being 61 per cent. calculated for the crude oil. The pure cineol was prepared from the phosphoric acid compound and its characters determined.

Pinene.—The first two fractions were again distilled and the lower boiling portions treated, 20 cc. at the time, with 50 per cent. resorcinol to remove the cineol. The unabsorbed portion was again agitated with fresh resorcinol until the cineol was removed. The oil left, after this treatment, was washed and dried. It had a strong odour of cymene and the following characters:—Specific gravity at 15° C. = 0·8670. Rotation a_D = + 7°·7. Refractive index at 20° = 1·4805.

These results indicated the presence of an active terpene; it was then again distilled, but the portion coming over below 163° was small; this had, however, a rotation 14°·4 to the right, and the refractive index was reduced to 1·4706. It is thus most probably that the small quantity of dextro-rotatory terpene present in this oil is pinene.

Cymene.—After removal of the terpene, as shown above, the portion boiling between 174 – 178° was 7 cc. This had a specific gravity at 15° C. = 0·8623; and refractive index at 19° = 1·4812. It was colourless, mobile, and had the odour and appearance of cymene. It was oxidised—2 cc. at the time—by heating on the water bath with 12 grams potassium permanganate and 330 grams water until reaction was complete. The oxide was filtered off, and the clear filtrate evaporated to dryness. The potassium salt was then boiled out with alcohol, evaporated, the residue dissolved in water and acidified. The separated acid was crystallised from alcohol. It melted at 155° C., and was thus shown to be p-oxyisopropylbenzoic acid, proving the prior presence of cymene in the oil.

The principal constituent in the oil after the cineol, is thus cymene. The residue in the still, boiling above 224° C. was heated with alcoholic potash to saponify the remaining esters, the oil separated and distilled. A portion came over at the approximate temperature required for a sesquiterpene, but it was too small in amount to identify with certainty.

Explanation of Plate.

1. Twig in flower.
2. Portion of a leaf showing underside.
3. Individual flower.
4. Individual stamen.

Figures 2, 3, 4, enlarged.

THE DIFFERENTIATION PHENOMENA OF THE PROSPECT INTRUSION.

By H. STANLEY JEVONS, M.A., B.Sc., H. I. JENSEN, D.Sc., and C. A. SÜSSMILCH, F.G.S.

With Plate II.

[*Read before the Royal Society of N. S. Wales, July 3, 1912.*]

Introduction.

IN the 1911 volume of these proceedings was published an account of the geology and petrology of the Prospect Intrusion.[1] This intrusion was shown to consist of an essexite (dolerite) occurring in the form of a saucer-shaped sill. It was also shown that the Prospect mass contains a considerable number of rock types differing in composition but clearly related to one another. Nowhere have we found any evidence whatever, that, after the consolidation of the main mass it was intruded by any foreign magma. The only phenomenon which might seem to require this explanation is the occurrence of what we have called pegmatitic and aplitic veins; but such an hypothesis seems to be rendered untenable by the following facts:—(1) that these veins have never been found penetrating the surrounding shales, (2) that they have no regular fine-grained selvage due to rapid cooling, (3) that, with the exception of ægyrine-augite, they consist entirely of minerals present in the main mass, though there is an augmentation of the felspathic constituents, and (4) that there appears to be in many places a gradual transition through rocks of intermediate composition from the main mass to the aplitic and pegmatitic types.

[1] The Geology and Petrography of the Prospect Intrusion by H. S. Jevons, H. I. Jensen, T. G. Taylor, and C. A. Süssmilch, this Journal, XLV, p. 445.

In this part of our communication we propose therefore, to seek the explanation of the origin of the various rock types we have described, assuming that all have originated *in situ* during the cooling and consolidation of a single magma, which may, or may not, have been homogeneous when intruded.

This paper is divided into two parts as follows:—

Part I. Differentiation Hypotheses by H. Stanley Jevons.

Part II. The Explanation of the Differentiation Phenomena of the Prospect Intrusion by H. I. Jensen and C. A. Süssmilch.

Part I was completed some five years ago, but its publication, for various reasons which it is not necessary to enter into, has been delayed until now.

Part I. Differentiation Hypotheses.

By H. Stanley Jevons.

Since there is as yet no consensus of opinion as to the origin of igneous species, it is necessary for me in this section to take a brief general survey of the various processes of differentiation which have been advanced in a general or particular manner, and to indicate the relative degrees of importance which I attach to them. My résumé of the subject is to a large extent based upon the presidential address on "The Evolution of Petrological Ideas," delivered before the Geological Society of London in 1901, by the present eminent Director-General of the Geological Survey of Great Britain.[1]

The following is a statement of the principal modes of origin of igneous rocks which have been, or may be suggested with a considerable probability of truth.

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[1] J. J. H. Teall, Section on "The Origin of Species," Q.J.G.S.. 1901, pp, lxxviii – lxxxvi.

The Methods of Origin of Igneous Magmas and Rocks.

(1) Unequal incidence of oxidising agencies on the primordial metallic substratum, which is assumed to have been itself already differentiated by gravity.

(2) Extensive melting and incorporation, due :—

(*a*) to release of pressure through earth movements.

(*b*) to high temperature of intruding magma.

The incorporation may be (*a*) complete or (*b*) partial, the fusible constituents being separated either by being squeezed out by earth movement or in other ways.

(3) Emulsation (Liquation in the sense of Durocher and Backstrom).

(4) Separation of earlier products of crystallisation in the following ways:—

(*a*) Sinking of crystals.

(*b*) Fractional crystallisation on cooling surfaces.

(*c*) Mechanical separation of mother liquor :—

(i) by earth movements squeezing it out into cracks.

(ii) by contraction of a solidified crystal network.

It is obvious that no one process of differentiation will account for all the different rocks in existence; and, in my opinion, everyone of the modes of formation of igneous magmas and rocks above enumerated can be proved to have been actually operative in one case or another. The principal questions to be considered here will be the conditions under which the processes operate. I have purposely omitted reference to hypotheses which are now generally discredited, such as Bunsen's theory of mixture of normal pyroxenic and trachytic magmas, and Soret's diffusion principle.

There is extremely little evidence available as to the mode of origin of abyssal rocks, so that it is impossible to verify or disprove speculations on this subject. Hypotheses may be obtained deductively, however, from certain general principles and well established facts. The extent of their truthfulness is then dependent on the completeness of the facts taken into consideration, and the soundness of the reasoning. Proceeding from our knowledge of the specific gravity of the earth, and the analogy of meteorites, we conclude that the greater part of the interior of the earth consists of uncombined metallic alloys, perhaps chiefly iron. Whilst the earth was still molten, however, the heavier metals must have tended to be aggregated towards the centre, and the lighter elements (such as silicon, aluminium, and the alkalies) towards the surface. As the earth's incandescent atmosphere cooled, the oxygen would probably unite first extensively with silicon, aluminium, sodium and potassium. Either at once, or before the temperature had been much lowered, some of the abundant silica would combine with these other oxides forming the polysilicates, which later crystallised as felspars. Oxygen would be carried to lower strata partly by water vapour, and partly by elements forming more than one oxide. Silica might be conveyed by the poly- and meta-silicates which would be reduced to meta- and orthosilicates by the native metal in presence of water-vapour, sulphur-dioxide, etc., producing an olivine-ijolite or nephelinite magma. This oxidation of the lower metallic stratum, consisting chiefly of iron with magnesia alloyed in it, would be assisted by frequent disturbances due to rapid contraction of the half formed crust. Thus a granite magma might be mixed with an olivine-theralite magma, and produce a gabbro or essexite magma. I believe, however, that the vast predominance in quantity of acid rocks such as granites and granitic gneisses, schists, etc., over more basic rocks in the cores of old mountain

ranges is good evidence that there never was an intimate mixing of the upper and lower layers of the crust.

At some considerable depth there is, probably, a like predominance of basic rocks and magmas, which have only here and there, through exceptionally deep orogenic movements, been forced up to the surface and upper parts of the crust. I do not, therefore, believe that there has ever been a primordial magma of uniform composition from which granitic and gabbroic types were derived by differentiation, but there was a primitive magma of granitic composition which, by admixture and selective reaction with varying proportions of the molten metallic substratum (also itself probaly varying somewhat in composition from place to place), formed various basic and intermediate magmas. By "selective reaction" I mean that those metals having the greatest affinity for oxygen and silica would be silicified first and absorbed into the magma, whilst, except under peculiar circumstances, such as may have caused native iron to remain in certain basalts, the unoxidised metal would sink through the magma like molten iron through the slag in a blast furnace, and be left behind when the magma was extruded.

It will be remarked that I postulate, throughout the whole of this discussion, a high degree of fluidity for the magmas considered, which some authors, having in view the experiments of Joly, Fonqué and Lèvy, and others, in melting silicates, are not disposed to admit. I grant that there is much geological evidence that magmas containing free silica are usually very viscous when intruded near the surface, or are erupted. Aplite veins, and the apophyses of granite masses, on the contrary, have every appearance of having been much more fluid, doubtless owing to their high temperature, and to the water-vapour and other gases they retained under the high pressure existing at great

depths. Basalt spreads out in sheets almost like water when erupted in large quantity, and at high temperatures and the pressures of great depths must be extremely fluid. Probably there is an actual decrease of viscosity up to a certain depth owing to the retention of gases; but in any case the ratio of motive force to viscosity almost certainly increases considerably with depth. It appears to me, therefore, quite legitimate to assume that all basic magmas, and, at some depth, all intermediate magmas, are highly fluid; and that at great depths acid magmas are fairly fluid. On the other hand, intermediate lavas must be considered to be rather viscous, and acid magmas near and at the surface highly viscous.

With the constant earth movements which probably agitated our globe before it was cool enough for life to originate, magma and solid rock must frequently have been forced into different positions in the crust—usually higher, but often, also, relatively lower—that is to say, beneath adjoining portions of the crust. As the result of such movements, there must have been not only the progressive silification of the metallic substratum already mentioned, but also, I think, extensive melting up and assimilation of previously formed igneous rocks, due both to release of pressure, and to the high temperature of a magma. In the Alps and Western Highlands of Scotland, and in numerous other cores of mountain chains, we have in streaked gabbros, diorites, etc., abundant evidence of melting up with incomplete mixture. When the mixture has been complete there exists no reliable means of proving it. Is it not likely that at greater depths than are anywhere accessible to us a considerable amount of remelting and mixture has taken place?

My conclusions, briefly stated, are that plutonic magmas are not for the most part the result of differentiation as

usually understood, but rather of gravitational differentiation in the original uncombined (or partly combined) constituents of the earth's "photosphere"—to use the solar analogy—followed by partial mixture and chemical reaction caused by crust movements. According to this theory certain gneisses of mountain ranges would be some of the first consolidated parts of the earth's crust; and siliceous magmas (as distinct from mixtures of liquid metals) would be produced by earth movements causing silicification of the metallic substratum, and by mixture subsequently from time to time, though naturally most abundantly in the earlier part of the earth's history. It should be noted that there is no reason, on this hypothesis, why any great body of magma forced into a new position in the earth's crust should not be of varying composition in different parts *ab initio*.

Differentiation I regard as a generic name for a number of very different processes by which all the various original siliceous magmas are subject to a further change, sometimes slight, sometimes radical in character. The origin of any particular rock may, then, have been simple, or it may have been complex. Some rocks have probably consolidated from an original magma, little changed since oxidation and silicification were completed; others may have been produced from a magma which was differentiated several times whilst completely liquid, and perhaps altered by assimilation, a final differentiation taking place during crystallisation. It is thus possible that rocks virtually the same in composition may have arisen in many different ways, some by very round-about processes of differentiation and mixture. The only test of derivation from a common magma, or at least, from magmas some parts of which had a common origin sometime in their history, is consanguineity —the presence throughout the series of rocks of some

unusual chemical constituents, or of some specific peculiarity of the minerals in habit, colour, or inclusions.

So far as the properties of mixtures of molten silicates are known, the latter obey laws closely analogous to those exhibited by solutions and mixtures of liquids at ordinary temperatures. Until the contrary is proved it seems to me very reasonable to suppose that the analogy is a near one; and this assumption simplifies considerably the task of finding the processes by which differentiation most probably takes place. We may assert with confidence, in the first place, for instance, that differentiation must be the result of a change either of temperature (usually cooling), or of pressure; probably, usually, of both.

The only process of differentiation which actually occurs in mixtures of liquids without any connection with consolidation is what was termed by Durocher liquation.[1] Certain liquids, (say A and B) are miscible in all proportions (consolute) above a certaln temperature, but as they cool they separate into two immiscible liquids, one a saturated solution of A in B, the other a saturated solution of B in A. As the temperature is lowered further, each liquid is saturated with a smaller and smaller percentage of the other, till one or both of them may become nearly pure. When the separation first takes place an emulsion is formed; but if the liquids differ in specific gravity, the heavier gradually collects as a layer beneath, and distinct from the other, the separation being quicker the greater the difference of density, and the less viscous the liquids. The familiar example is phenol and water;[2] and others are

[1] Enc. Brit. 9th ed. x, 223a, from translation in Haughton's Manual of Geology, 1866, p. 16.

[2] Teall, Q.J.G.S., 1901, p. 79. Whetham, Solution and Electrolysis, 1895, p. 17; Nernst, Theoretical Chemistry (trans. Palmer, Macmillan, 1895) p. 411; W. D. Bancroft, The Phase Rule, (Cornell Univ., Ithaca, N.Y., 1897). pp. 102 and 126. I should like to draw attention to the important bearing of the information contained in the last two works upon the physics of rock-magmas.

naphthalene and water, and sulphur and toluene. The addition of a third constituent considerably complicates the phenomena. There is not much experimental work on the properties of mixtures of three liquids; but apparently the results vary according to the solubility relations of C with A and B respectively; so that C may either raise or lower the temperature of separation into two layers, prevent it altogether, or produce a separation into three layers, according to its nature. The problem is also complicated by the fact that some pairs of liquids after becoming less soluble in one another begin to become more soluble in one another and sometimes miscible again in all proportions, as cooling is continued, before or after the crystallisation of one of the constituents has begun.

In a rock magma there are usually ten or twelve different silicates present, some of which crystallise together, besides water and two or three oxides. Whilst this renders a complete mathematical or experimental discovery of the properties of such a magma virtually impossible, it does not alter the nature of the laws to which they conform nor preclude the possibility of liquation. We must remember, however, that any one of these numerous constituents may have the property of greatly altering, in accordance with the proportion of it present, the conditions of temperature and pressure at which a given magma liquates. It is greatly to be desired that experiments should be undertaken with mixtures of molten silicates under high pressures and in the presence of water vapour. The chief difficulty, no doubt, is the costliness of the apparatus that would be necessary to maintain a very high pressure at a high temperature. In default of experiments we must rely on petrological evidence; but this is not likely to be abundant, because it would be only when the differentiation

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[1] Bancroft, *ibid.*, p. 238. [2] *Ibid.*, p. 103.

was caught by consolidation at a certain transient stage that any identifiable record would remain. If crystallisation occurred soon after emulsification, each globule would probably form one crystal, or only part of one, and the resulting rock would not differ from one crystallised from a homogeneous magma. On the other hand, if the magma had been sufficiently hot and fluid for nearly complete separation of the heavier liquid, we should find a mass probably richer in femic minerals in its lower part, passing more or less gradually into a more acid rock into the upper part, a phenomenon which might have been caused by other methods of differentiation. It would only be where the minute drops of the emulsion had united into larger globules, and where for some cause, such perhaps as the viscosity of the magma, or the rapidity of cooling, these globules had not sunk to form a lower layer, that we might expect to find traces of them preserved. Such a case appears to be the granite with spherulites crystallised from without inwards described by Bäckström. Is it not possible that if the attention of petrologists were more uniformly directed to the characters of liquation phenomena, further discoveries of them would be made?

Differentiation during Consolidation.

Differentiation may occur during the consolidation of a magma in several ways, all of which, however, merely amount to the separation of the earlier formed minerals from those crystallising later. The simplest method is by the sinking of the first formed constituents. When these are femic minerals their specific gravity must be considerably greater than that of the magma in which they form, for they are denser than the average specific gravity of the solid rock, and the latter is greater than the specific gravity of the same rock in the liquid state.[1]

[1] According to the data of Barus, and the observations of Joly who noticed considerable expansion of rock on melting.

I have already mentioned my belief in the fluidity of all except the acid magmas under moderate subterranean pressure; and, if this be granted, the sinking of the earlier formed crystals, rendering more basic the lower part of a mass, may be regarded as being probably a not uncommon type of differentiation. It has been described by Darwin[1] and Iddings. I venture to suggest that the familiar basic concretions in granites have been formed in this way. If a layer of small crystals had hardened over the bottom of a magma cavity, or in the duct which fed it, a further intrusion of magma, such as probably frequently occurs, would break up this hard layer and partially incorporate the fragments, leaving subangular pieces such as we find.

It should be remembered that under certain circumstances the sinking of heavier constituents either during crystallisation, or by liquation, can produce both the appearance of an acid centre bordered by basic rock, and the reverse, namely a basic centre and relatively acid periphery, the actual appearance depending on the extent of denudation. Some of the intruded magma cools on the walls of the cavity before differentiation takes place, then the heavier constituents sink to the bottom, and the lighter magma remaining (usually more acid) occupies the centre of the upper part of the cavity. According to whether denudation has drawn the surface along the upper portion or the lower portion, so will the centre be more acid or more basic than the border. It is possible that the laccolite of Ramnäs[2] is an example of the latter, whilst the nepheline-syenite-shonkinite laccolite of Square Butte, Montana,[3] is probably an example of an acid centre produced in this way, the mineral differences indicating liquation as the probable process of differentiation in the latter case.

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[1] Volcanic Islands (1844).

[2] Brogger, Zeit. f. Kryst., XVI, (1890) p. 45; akerite in centre (SiO_2 58·5) quartz porphyry at periphery (SiO_2 71·5).

[3] Bull. Geol. Soc. Amer., VI, (1895) p. 389.

Probably the most important method of differentiation during consolidation is fractional crystallisation, as it has been denoted by Becker. The crystals of salts crystallising from an ordinary aqueous solution are always deposited upon the cool surface unless either crystallisation is rapid, when they form also in all parts of the liquid and sink, or the solution is viscous. By analogy we can quite understand that a fairly fluid magma would deposit the first products of crystallisation on the walls of the chamber it occupied. Of course, the supersaturation of the neighbouring magma as regards the constituents separating is exhausted by any accretion of the crystal;[1] and to restore this supersaturation by diffusion alone would require an impossible length of time, as shown by Becker. Hence differential crystallisation on the cooling surface can only take place when mechanical agitation constantly renews the magma in contact with it; and this can happen in two ways, either by convection currents due to the cooling of the magma, or by slow earth movements. Convection currents must exist when the magma is fairly fluid, and the only other condition is that the magma is not cooled rapidly. Probable examples of this kind of differentiation are the Carrock Fell gabbro described by Harker,[2] (case of Becker's laccolite), the essexite mass of Brandberget with its pyroxenite border,[3] and perhaps the laccolites (?) of Yogo Peak and Bearpaw Peak in Montana.[4]

Cases in which fractional crystallisation results from motion of the magma caused by earth movements are chiefly dykes, sills, flat laccolites, and pipes. The folding of strata is usually a very slow process, and in intrusions

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[1] Chemical Crystallography by A. Fock, (trns. Pope) p. 50, (Clarendon Press, 1895).

[2] Q.J.G.S., Vol. 50, (1894) pp. 311 – 335.

[3] Brogger, Q.J.G.S., L, (1894), p. 31.

[4] Weed and Pirrson, Am. Jour. Sci., Vol. L, (1895) p. 467 and Vol. LI, (1896) p. 351, respectively.

connected with such folding the magma may probably be moving slowly through a horizontal or vertical fissure for many years. During the whole of this time a magma of nearly uniform composition may be passing into the fissure, but on the walls of the part first intruded the earlier products of crystallisation will have adhered and will continue to do so, as long as the magma is passing. When it ceases to flow, a magma which has already parted with some of its early crystallising constituents consolidates between two sheets of those constituents.

There is another kind of differentiation which is probably common but usually produces rocks on a small scale only. A mechanical separation of the mother liquor may happen after crystallisation has been nearly completed throughout a mass of cooling magma by its being squeezed out by earth movement along the planes of least resistance in the surrounding rocks. Many granite-aplites, and other aplitic rocks generally, such as bostonite, diorite-aplite. etc., which penetrate the country-rock, may have been produced in this way. A second mode of separation is that which, I believe, produces the vast majority, if not all, of those aplitic veins which are found traversing plutonic, and the larger hypabyssal masses, whether basic, intermediate or acid, though most frequently in the last. In any part of the cooling mass where consolidation is more than half completed, the earlier formed crystals must be adhering to one another at so many points that they build up a kind of solid net-work, or sponge. As the mass continues to cool the crystals contract, and the spongy mass divides along planes in three directions; one parallel to, and the others roughly perpendicular to, the cooling surface. At the same time the mother liquor in the interstices of the crystal network has no option but to percolate slowly out into these cracks, under the pressure of the contraction, which is squeezing it out like water from a sponge. There is

never, of course, an open crack, the mother liquor exuded always filling the plane of parting; because the contraction due to the cooling of the mass as a whole, which results both from crystallisation and from cooling, is probably taken up during the earlier stages of cooling, by the pressure of the superincumbent strata. During the later stages of consolidation and during subsequent cooling further contraction leaves actual spaces between the crystals,—the so-called miarolitic cavities. This name has been applied, not only to intercrystal spaces, but also to the larger irregular cavities sometimes occurring in plutonic rocks, which I regard as pockets of aqueous and other vapours, or of watery solution miscible with the magma. They are, I believe, simply plutonic steamholes, of the same nature as the original cavities of amygdaloidal lavas; the conditions giving rise to them are rarer.

The common texture of aplitic rocks is well accounted for by this theory of their origin. There must be a slow but constant motion in the liquid whilst it is slowly aggregating in the cracks from the surrounding mass, and this liquid is all the time slowly crystallising. A constant slow movement, continuing almost to the completion of crystallisation, is the best explanation of the origin of an even-grained allotriomorphic texture. Crystallisation would probably at any one moment be slightly more advanced in the centre part of the vein than at the sides which were being recruited with fresh mother liquor, but such a time-difference need not have any appreciable effect upon the texture of the solid rock. The theory which I have just stated is the one which has for many years seemed to me to give the best explanation of the phenomena of aplitic veins, and I have had it in mind when examining numerous examples of aplitic veins in the field, and I have seen no occurrences which were in any way inconsistent with it.

It is surprising that many authors finding aplitic veins in rocks other than granites, still remark upon them as something unusual; often indeed, they do not connect them with the aplites of granite. Personally, I think that aplitic veins should be regarded as a normal feature of all but the smallest igneous masses; and some unusual conditions of cooling, or properties of the magma, must be invoked to explain their absence in particular cases.

The extension of the aplitic veins of the larger plutonic rocks for a moderate distance into the surrounding country rock is easily accounted for by the fact that the latter must have been strongly heated, and on cooling will open in cracks. Where aplites are a very prominent feature of the surrounding country rock, I take it that their injection is due to earth movements as above suggested.

A few words as to the origin of pegmatite veins. Those which contain no exceptional minerals, and are merely of the nature of the plutonic rock, but more acid and very coarsely crystalline, may have crystallised, I think, from a magma very rich in water, and thus highly fluid. The large size of the crystals is thus accounted for, because coarseness of grain results as much from fluidity of the magma as from slowness of cooling. Probably such an aqueous magma would arise during the early stages of crystallisation; and it would be miscible (on the liquation theory) with the general body of the magma, and with the aplitic mother liquor, in the manner which will be described for the Prospect mass in the next section. The very coarse pegmatites, often containing rare minerals, with sometimes stratified, or at least non-uniform, structure, which sometimes extend for great distances away from the mass, are probably to be accounted for by what is generally known as pneumatolytic action. This I take to be merely the extrusion from the solidifying mass of dilute aqueous

solutions of silicates at a very high temperature, possibly above the critical temperature, and thus highly fluid, if not actually gaseous. The very coarse pegmatites might, indeed, be regarded as crystallised from the mother liquor of the more normal pegmatites just mentioned; because the latter would be deposited first, and from the outwardly passing hot solution, and thus nearer to or within the mass.

Part II. Explanation of the Differentiation Phenomena of the Prospect Intrusion.

By H. I. Jensen and C. A. Süssmilch.

The features of the Prospect Intrusion explainable by one or more of the differentiation hypotheses outlined in Part I, are

1. The Banded Nature of the Intrusion as a whole.
2. The Segregation Veins.
3. The Sub-alkaline nature of the whole intrusion.

1. The Banded Nature of the Intrusion.

A full description of the variation in mineral composition of the Prospect essexite appears in our previous paper (p. 513). It was shown that there was a progressive change in mineral composition from the upper margin of the intrusion down to a depth of about 65 feet, while below that depth the essexite was, as far down as it is exposed, of a uniform composition. As a result of these variations the upper part of the intrusion is divided into definite layers as follows:—

		Depth below top. (Metres.)	Thickness. (Metres.)
A. *Pallio-essexite*		1 – 4	4
B. *Essexite, felspathic phase*	(*a*) Essexite	4 – 13	9
	(*b*) Upper segregation vein		
	(*c*) Essexite	13 – 17	4
	(*d*) Lower segregation vein		
	(*e*) Essexite	17 – 19	2
C. *Essexite, normal phase*		19	(not known)

Most of these layers are shown in Fig. 1. The felspathic phase of the essexite (layer B) contains the two large segregation veins as shown; these will be dealt with later and will not be further discussed in this section.

The mineral composition of these different layers is as follows:—

Table I.

	Pallio-essexite.	Essexite, Felspathic phase (excluding the Segregation Veins).	Essexite, normal phase.
Felspar (Plagioclase)	37 – 39%	45 – 56%	38%
Augite	30 – 33	20 – 34	38
Olivine	14 – 21	4 – 8	5
Ilmenite	4 – 7	3 – 14	16
Biotite	0 – 11	2 – 7	1
Apatite	0·1 – 1·0	0·7 – 2·0	0·4
Orthoclase	1	0·15 – 5	2

A. *Origin of the Pallio-essexite.*—This forms a selvage to the intrusion and has a thickness of from three to four metres. It will be seen from the above table that the border facies of pallio-essexite is (*a*) richer in olivine and biotite, (*b*) poorer in augite and ilmenite than the normal essexite; further its felspars, although about equal in quantity are somewhat more acid. In addition the pallio-essexite is aphanitic in texture, whereas the essexite is phanerocrystalline.

The larger proportion of olivine, and perhaps also of the biotite, appears to be the result of fractional crystallisation at an early stage of solidification. The outer zone of the intrusion in contact with the cold shales, would, owing to rapid conduction, soon have a somewhat lower temperature than the main mass of the intrusion. Crystals of olivine would begin to develop in this zone at a time when the main mass of magma was still too hot for this mineral to crystallise. For olivine to develop in excess of the amount

present in the original magma, as is the case, their growth must have been fed with material by convection currents from other parts of the intrusion, as described by H. S. Jevons in Part I. Harker[1] is of opinion that convection can play at most a minor part in fractional crystallisation, and considers diffusion to be the means by which the degree of supersaturation for crystallisation is maintained. The other differences in mineral composition require a different explanation. The pallio-essexite, as shown by its position and finer grain size, must have solidified while the bulk of the intrusion was still molten, and probably acted as a slow conducting layer which retarded the cooling and solidification of the intrusion as a whole. The main body of the essexite solidified much more slowly, and was, as will be described presently, subjected to other processes of differentiation which produced firstly the felspathic phase of the essexite, and secondly the differentiation veins (essexo-aplite and essexo-pegmatite); the already solidified pallio-essexite therefore escaped these later differentiation processes, and, except for its higher proportion of olivine (and perhaps biotite) produced by fractional differentiation as already described, it may be taken as representing the original magma of the intrusion. This would explain its lower content of augite and iron ores and its more acid felspar.

Absorption of the overlying shales is a possible factor which must not be overlooked. These shales are of a silicious type, and have been somewhat indurated for a distance of about twelve inches from the junction; in places they appear to have been actually fused by the heat of the intrusion. This question of chemical assimilation of the shales has already been fully discussed in our previous paper,[2] and the conclusion arrived at was that only very slight assimilation had taken place.

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[1] The Natural History of Igneous Rocks, Alfred Harker, M.A., F.R.S., p. 319.

[2] Geology and Petrography of the Prospect Intrusion, this Journal, 1911, page 521.

B. The Felspathic Phase of the Essexite.—This lies between the pallio-essexite and the normal essexite and has a thickness of about sixteen metres; it includes the two larger segregation veins whose origin will be discussed later. By reference to Table I, it will be seen that, as compared with the normal essexite, it is notably richer in felspars and biotite, and correspondingly poorer in augite and ilmenite. These differences cannot be due to fractional crystallisation, because while biotite was one of the earlier minerals to crystallise, felspar was one of the later, and these two minerals are notably coincident in this zone. The junctions between this zone and the zones of pallio-essexite and normal essexite above and below are not absolutely sharp, although the change from one to the other is fairly sudden. The distribution of the minerals is not uniform throughout this felspathic zone, for while everywhere higher in felspar than the normal essexite, that part adjacent to the pallio-essexite is more basic than that lower down (see table on page 514 in our previous paper). This upper portion is also finer grained than the lower portion.

Two possible causes suggest themselves in explanation of these features, (*a*) gravitational sinking of the heavier minerals during the earlier stages of crystallisation, (*b*) a partial liquation of the magma before crystallisation had begun, *i.e.*, a separation into two layers, the one more salic and of lower specific gravity above, the other more femic and heavier below. While admitting that liquation may have been a contributing cause, we are of opinion that gravitational sinking of the heavier minerals was the main cause. The fact that the upper part of this zone is more basic than the lower may be explained as being due to its more rapid solidification, as shown by its finer grainsize, having allowed less time for gravitational sinking to operate.

C. *The Normal Phase of Essexite.*—This appears to constitute the great bulk of the intrusion, its total thickness is unknown, and the maximum thickness exposed is about sixty-five feet (in the Reservoir Quarry). As compared with the original undifferentiated magma it has been impoverished by the concentration of olivine in the pallio-essexite, by the relative concentration of felspars and biotite in the felspathic zone, and also by the concentration of alkaline minerals (albite and egerine) in the segregation veins. To what extent it differs from the original magma as a result of these impoverishments it is, in the absence of any positive knowledge as to its thickness, impossible to say. It is probable, however, as stated above, that the rapidly cooled pallio-essexite, after deducting the excess of minerals resulting from fractional crystallisation, most nearly represents the original composition of the magma.

2. The Segregation Veins.

The nature and distribution of the segregation veins has been fully described in our previous paper (p. 526). The two large veins therein described, occur in the felspathic zone of the essexite, and one of them is shown in figure 1.

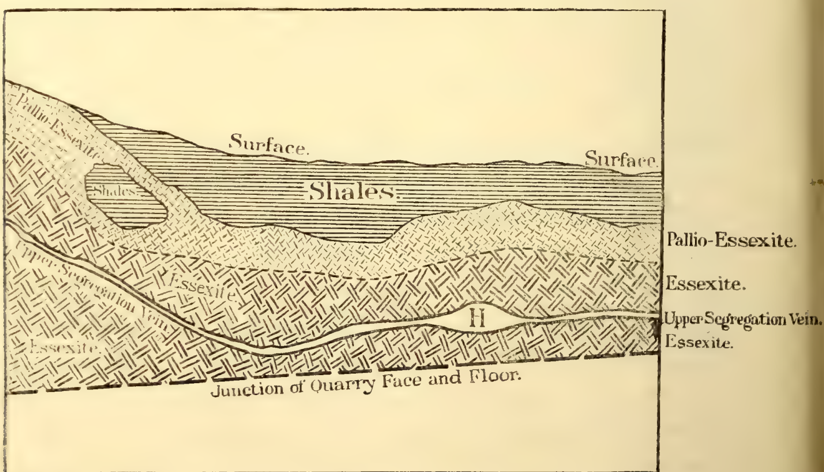

Fig. 1.—*Sketch of part of the face of the Reservoir (old) Quarry.*

It will be seen that it parallels in a remarkable way the upper surface of the intrusion, and is about nine metres below the junction of the intrusion with the shales; the one not shown is parallel to it, and about four metres below it. These two veins have a thickness varying from 15 cm. up to 120 cm., and contain two distinct rock types, which we have called essexo-pegmatite and essexo-aplite respectively. The relation of these rocks to one another, and to the essexite proper is shown in figure 2.

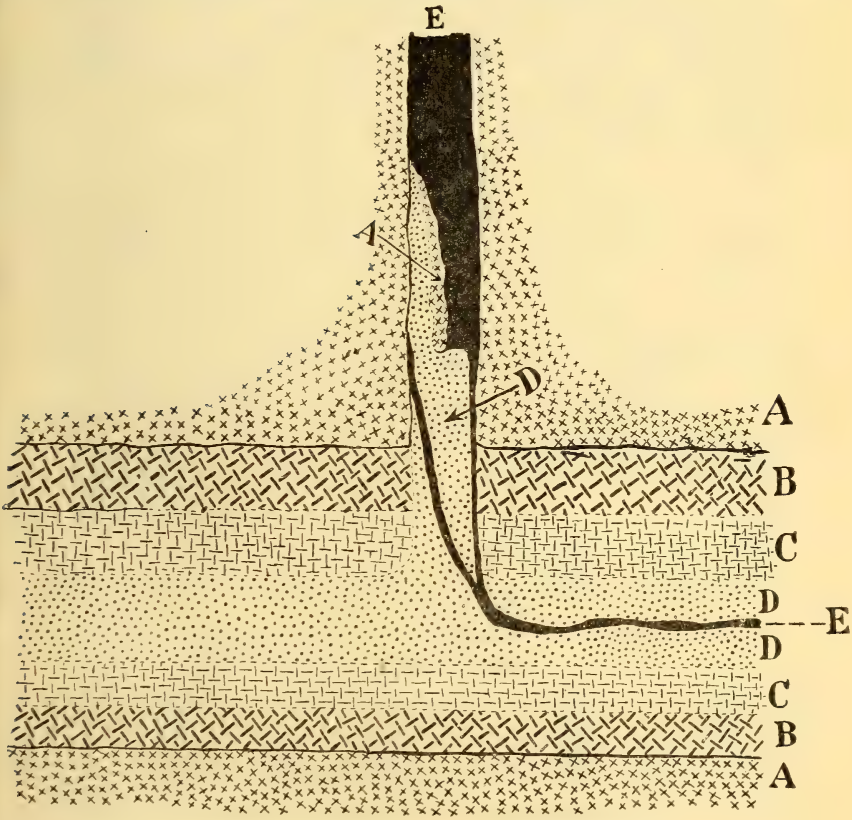

Fig. 2.—*Sketch of part of one of the larger Segregation Veins.*
A Essexite (dolerite); *B* Fine essexo-pegmatite; *C* Coarse essexo-pegmatite; *D* Fine aplite; *E* Coarse aplite.

In addition to these two large segregation veins there are a number of smaller veins situated above, between and below them, running in no general direction and seldom more than two or three inches in thickness; one of these is shown in figure 2, branching off from one of the larger veins. These smaller veins in nearly all cases, contain essexo-aplite only. None of the segregation veins extend into the more compact part of the zone of pallio-essexite.

The two rock types occurring in the segregation veins are notably different from the essexite, and differ also from one another. The mineral composition of these two rocks together with some of their physical characters, are set out for comparison in the following table :—

Table II.

	(1) *Essexite.*	(2) *Essexo-pegmatite.*	(3) *Essexo-aplite.*
Grainsize	0·5 – 3 mm.	(*a*) 2·5 – 3 mm. (*b*) 5 – 10 ,,	(*a*) 0·1 – 0·15 mm. (*b*) 0·25 – 0·75 ,, (*c*) 1 – 2 ,,
Fabric	Hypidiomorphic granular	Hypidiomorphic granular	Hypidiomorphic to panidiomorphic granular
Average Mineral Composition.	%	%	%
Orthoclase	nil	nil	nil in the mode 17·10 in norm.
Albite	nil	33·5	60·46
Labradorite	37·2	50·0	nil
Pyroxenes (augite)	40·5	augite, diopside, ægerite 11·0	diopside, ægerite 17·47
Olivine	4·9	nil	nil
Ilmenite	16·6	5·	4·38
Apatite	0·7	0·5	0·6

From this comparison we see that in passing from the normal essexite to the centre of the segregation veins we meet with—

(1) an increasing percentage of albite and orthoclase, from nil to 77·56%.

(2) a decreasing percentage of labradorite, from 37·2 to nil

(3) a progressive change in the pyroxenes, the augite being replaced by diopside and ægerite, the total percentage decreasing from 40·5% to 17·47%.

(4) a decreasing percentage of ilmenite.

(5) a total absence of olivine in the segregation veins.

Chemically considered the variation is as shown in the following table:—

		(1) *Essexite.*	(2) *Essexo-pegmatite.*[1]	(3) *Essexo-aplite.*
Increasing acidity	SiO_2	41·05	...	58·82
,, alkalinity	$K_2O + Na_3O$	2·96	8·08	9·70
Decrease of Bases	CaO	10·96	...	2·42
	FeO	11·07	...	4·59
	MgO	6·38	..	0·88

It will be seen from Table II, that the essexo-pegmatite is intermediated in its composition between the essexite and the essexo-aplite. The coarse variety of pegmatite is somewhat more acid than the fine grained variety. An examination of figure 2 will show that the order of formation of these rocks was as follws:—

1. Essexite.
2. Fine essexo-pegmatite.
3. Coarse essexo-pegmatite.
4. Fine essexo-aplite.
5. Coarse essexo-aplite.

The pegmatite, when it occurs in the same vein with the aplites, always occurs at the sides of the veins and merges by imperceptible gradation into the essexite proper, the coarser and finer types also merge into one another; the junction between the pegmatite and aplite is always fairly sharp. There is no real textural difference between

[1] No complete chemical analysis of the pegmatite is available.

the pegmatite and essexite except that it is usually coarser grained. These pegmatites do not appear to have been formed by any kind of pneumatolytic action; the absence in them of pneumatolytic minerals and their texture dispel any such idea. They are then, not altogether comparable with such of the granite-pegmatites which have had a pneumatolytic origin.

The aplite is invariably finer grained than the essexite and is always more or less miarolitic. Three varieties, according to grainsize, are shown in Table II, but at any one particular place the aplite usually consist of two types (*a*) fine and (*b*) coarse. The former is fairly uniform in character and is usually aphanitic (microcrystalline); the latter is very variable in grainsize and phanero-crystalline, the grainsize in both cases tending to increase with the thickness of the vein. The fine grained type of aplite occurs in the large veins either as (*a*) a definite band on either side of the coarse aplite, (*b*) as irregular rounded patches in the coarse aplite or (*c*) filling the centre of the vein to the exclusion of the coarse aplite. The coarse always occurs, more or less, in the middle of the vein, sometimes as a mere thread (see Fig. 2) sometimes as a network of irregular veins traversing the fine aplite or even the pegmatite, at places swelling into large masses, sometimes disappearing altogether.

The coarser aplites are strongly miarolitic and contain in many places fairly large elongated cavities. Where the coarse aplite occurs as a thin vein in a finer-grained aplite as shown in Plate II, it is strongly miarolitic, and there is a tendency for the felspar tables to stand approximately at right angles to the walls of the vein. Such thin veins may have been formed, by pneumatolytic action. In their appearance and structure they resemble the thin segregation veins of the Bostonite of Bowral (N.S.W.).

The dimensions of the different rock types in the specimen shown on Plate II, as measured from top to bottom about half an inch from the left side of the plate are as follows:— Pegmatite 12 cm., fine aplite 20 cm., coarse aplite 5 cm., fine aplite 42 cm., pegmatite 85 cm. The specimen as shown is not the full width of the vein, some of the pegmatite is missing.

Origin of the Pegmatites and Aplites.

Liquation has probably been the main factor in the formation of these more acid and alkaline rock types. As the cooling of the whole mass of the intrusion advanced, the more acid and alkaline portion of the mixture showed a tendency to separate from the more femic portions because of the greater miscibility of the former with the magmatic water present, which tended to retain the acid constituents in a fused state; this acid portion of the magma became a mother liquor. As crystallisation advanced, the mass cooled, and contraction fissures developed. At this period that portion of the magma undergoing crystallisation would be expanding slightly, but those parts of the mass in close proximity to the surrounding shales had already consolidated, and were experiencing the contracting effects of relatively rapid cooling. The contracting portions were rigidly connected with the overlying fused and indurated shales, and as the consolidated portions contracted they were drawn towards the exterior of the mass, thus causing cracks to develop in the zone immediately below. This would account for the parallelism between the main segregation veins and the upper margin of the intrusion.

Into these contraction fissures, as fast as they formed, would be squeezed a mixture of residual magma (rich in magmatic water) and mother liquor, from this the pegmatites crystallised. The somewhat higher acidity and coarser grainsize of the coarser variety of pegmatite would be due

to the increasing proportion of magmatic water and mother liquor introduced as vein formation continued.

The aplites were clearly formed after the pegmatites, and resulted from the crystallisation of mother liquor only. This mother liquor, owing to its high water content, remained fluid at a much lower temperature than the rest of the magma. After the pegmatites had finished forming, contraction of the now practically solid mass still continued, the two large veins still continued to widen, while a number of smaller cracks, more or less at right angles to them developed. Into all of these fissures mother liquor was squeezed, and from its crystallisation the aplites developed. The progressive increase in the grain size of the aplites was due, no doubt, to a progressive increase in the proportion of magmatic water present, the water content at the later stages being increased by the expulsion of magmatic water by the earlier formed finer grained aplites. That there was a high water content and ample space at the time of crystallisation is shown by the strongly developed miarolitic structure of the coarse aplites. In this last stage of vein formation, pneumatolysis possibly played some part. The reopening of the veins after the fine grained aplite had solidified, fractured and fissured this earlier formed type; this would account for the patches of fine aplite which occur in places in the coarse aplite, and the thin veins of the latter traversing the former, as shown in figure 2.

The disposition of the segregation veins at Prospect, their absence in the more compact part of the pallio-essexite, and their absence in the shales, are evidence, in our opinion, that (*a*) the load of sedimentary rocks overlying the intrusion was not great, and (*b*) that the theory of bending or arching of the shales over the rim of the intrusion is probably more correct than that of breaking and faulting, since

the formation of a circular fault would have placed a considerable load on the intrusion. A heavy load pressing on the intrusion would have prevented the formation of the two large contraction fissures which parallel the upper margin and would have tended to force the mother liquor into the shales along the fault cracks. The selvage of pallio-essexite formed at the beginning appears to have acted as an impervious screen, which reduced the rate of cooling, hemmed in the magmatic vapours, and gave the whole mass those peculiarities of texture which at first sight suggest origin at a considerable depth.

3. The Sub-alkaline Nature of the Prospect Intrusion as a whole.

The essexite of Prospect is so essentially similar in chemical and mineral composition to the other Tertiary basic igneous rocks of the Sydney, Blue Mountain and Illawarra Districts, that there can be no question that they have all been derived from a common magma, and that the region in which they occur is a petrographical province, as already pointed out by G. W. Card.[1] It has also been claimed by one of us,[2] that the whole of Eastern Australia had been a single petrographical province throughout Tertiary Time.

Even if this petrographical province be limited to the central-eastern part of New South Wales, it still contains a great variety of volcanic and hypabyssal intrusive igneous rocks ranging from very acid to very basic and from highly alkaline (15% or more of alkalies) to sub-alkaline or even calcic.

Any discussion of the origin of the magma which produced the Prospect intrusion necessarily involves, therefore, a discussion of the origin of all the Tertiary igneous rocks

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[1] Records Dept. of Mines N.S. Wales, Vol. VII, part 2, page 93.

[2] The Alkaline Petrographical Province of Eastern Australia, by H. I. Jensen, Proc. Linn. Soc. N.S.W., Vol. XXXIII, p. 589.

of this petrographical province. The exact relation of the intrusive members to the lavas has not yet been satisfactorily determined, nor has the order of succession for either the intrusive or volcanics been definitely decided for this region. Until more complete information is available upon these points, we feel that it is somewhat premature to theorize as to the origin of the magma or magmas from which these rocks were derived.

NOTES ON TWO LIGHTNING FLASHES.

By F. H. Quaife, M.A., M.D.

[Read before the Royal Society of N. S. Wales, August 7, 1912.]

Several years ago there was a short but severe thunderstorm, concentrated over the district of Paddington and west Woollahra, between 10·30 a.m. and noon. Light to medium heavy rain fell during it, and the lightning and thunder were mostly not of the more pronounced kind. Towards the end however, they became more marked, and then nearly immediately over head but slightly to the north, there was a blinding flash and instantly a crash, not at all like usual thunder, but crackling as of thousands of ordinary Chinese crackers exploding. My study faces south, and a friend and I seated in it did not notice the flash as so out of the common, but those in the back part of the house described it as above stated. It was evidently so close that I felt that some part of the premises had been struck. I ran out, and looked round to the back from the

verandah, but saw nothing, but my younger son rushed in and said that the lightning had struck a gas pipe piercing the wall of a workshop and had set the gas on fire. The gas was at once turned off at the meter, and an examination made. The workshop was covered, both as to roof and walls, with galvanized iron, the sheets on the western side touch the soil, those on the front not quite; both have fair contact with the roof; also an iron fence which runs from the side for about fifteen feet is embedded in the soil, which at the time was very wet. Inside the building the gas pipe is of iron, $\frac{3}{4}$ inch, and comes from the main service through an adjoining room; the main service being of inch pipe, which runs underground about 80 feet to the meter. The pipe ends a few inches outside the iron shed and is joined to a tin pipe, such as is often used in walls, which ran along the top of a wooden fence, on a batten, to a small laboratory; and in it did not go nearer the floor than about four feet six inches, where it terminated in the usual appliances for lighting and heating.

I found that the iron pipe, the building, and all the contents were uninjured, but that from the brass union the tin pipe was melted for some fifteen inches, and the tin spattered about. The rest of the pipe to the laboratory was uninjured; it was afterwards replaced by $\frac{1}{2}$ inch iron pipe as far as the laboratory.

A sewer ventilator about six feet above the skillion roof near its highest part at the back of the building pierced the roof, and was well flushed to it, but it went only into dry soil, and there of course into the top of the earthern trap. No damage occurred to these. As the interval between the flash and the extinguishing of the burning gas was only about two minutes at most, it is pretty clear that the heat of the lightning, that is of resistance, was responsible for most of the melting of the tin pipe. The difficulty

is to explain why the ventilator on the roof itself was not struck when there was so much metal surface leading to or standing on some fifteen feet of wet soil, rather than a tube close to the guttering and the eve of the well conducting roof; no doubt the gas pipe carried off a part of the discharge, and no doubt also the enormous potential and current spread itself over most of the metal parts.

On the 25th of February last (1912), there occurred a storm of terrific severity. It was Sunday when in the afternoon large numbers of people take their outing in the beautiful Centennial Park. Again the central disturbance was over part of the Eastern suburbs. The morning was close and muggy, and from noon onwards large stormy masses of cloud appeared rising in the south-west. With a friend, about 4·15 p.m., I went out for a walk, and, as we usually did, made our way to the kiosk for some tea; a storm was clearly advancing rapidly, and a high bank of curiously whitish cloudy curtain preceded the dark leaden masses. We had only sat a very short time when the faint rumbles began, and it grew excessively dark. Frequent flashes occurred, and increased in severity with tremendous thunder, and the rain at first light, soon became denser, and fell in torrents, so thick that we could not see more than a few yards into it. The flashes got so frequent that for a few minutes at the height of the storm, there seemed only from 10 to 20 seconds between them. They culminated in two extraordinary ones, with more of the crackling kind of thunder, and certainly not more than two seconds between flash and crash. This would give about 2,200 feet distance from the kiosk. These occurred about 5·30 p.m. Soon after this the clearing followed and we were able to go home.

About seven o'clock I was going across to St. Matthias' Church in the dusk, when two ladies told me that the

church had been struck and was on fire. What happened was that at about 6·30 p.m., a man passing saw some light inside and smoke rising from the roof; he immediately warned the Rectory and the fire engines were called. When an entrance was made it was found that the church was full of smoke, and that flames were running down the inside of the roof along the nave and as far as the junction of the principals of the transepts with those of the nave. It was the custom to leave the gas on at the meter, and it was found as soon as could be that the gas had been lit at a tin pipe leading down to a bracket on the south transept wall, and that a yard or more was gone; afterwards I found the spattering of tin on a seat below. It seems certain that one of the two flashes referred to above had done the mischief. The effects were as follows: the lead valley joining the roof of the nave and transept on the southern side was melted for some distance above the guttering and a way opened into the interior close to where the tin pipe crossed over a principal on its way down from its junction with the iron pipe which ran along that principal. That pipe being the best way to earth, carried off and disposed of part of the charge, but the tin pipe being melted through and the gas lit, the further melting of the tin pipe resulted from the heat of combustion, and the gas flame also set the roof lining and the principal on fire. It must have been burning an hour before the discovery. The damage was considerable, but was soon limited by the engines. Owing to the tightness of the roof, the fumes of steam and carbonic acid gas must have helped to save the whole roof from destruction. There was no system of conductors, and none of the rain spouts reached the ground.

Here the flash dived into a hollow to attack the lead gutter instead of going for the prominent ridges. But the tin gas pipe about a foot from the valley was the nearest

point where a conductor leading to earth through the iron service was available.

According to the article on lightning in the latest and recent edition of the *Encyclopœdia Britannica*, which is based on the findings of three Commissions on the subject in Europe, no one conductor is of the slightest use ; all metal parts of the roof or other outside parts of the building should be well metallically connected, and all elevated structures, such as chimneys especially, owing to the hot fumes often rising from them, should be provided with pointed conductors. The more the building is covered like a bird-cage the better, and the best material is strong galvanized iron wire. Copper is more likely to favour side flashes, which often do more damage than the main flash. Of course all these metallic lines should lead to earth in several places, and should be fastened to large plates of copper sunk into damp soil or very deep laid water pipes.

The different layers of cloud form condensers and at the tremendous potential existing, the disruptive discharge becomes extremely erratic and takes by no means the paths that might be expected.

I was once called to see a woman in a small house, by no means on a hill, in Paddington. She was lying in a bed made up in a fourpost tubular bedstead. A flash had struck the roof and travelled down a bedpost, knocked out a loose gas board, run along a gas pipe which emerged in the kitchen, jumped from there to a piece of iron rod passing through the wall and thence to earth. A large piece of the wall was shattered and the bricks tumbled about and many smashed to dust. Fortunately, the woman escaped completely except for a scare. No doubt the cage form of the four-poster had a good deal to do with her escape.

NOTES ON A MODEL OF NEW ENGLAND AND THE ASSOCIATED TOPOGRAPHICAL FORMS.

By E. C. ANDREWS, B.A.

(By permission of the Under-Secretary for Mines.)

[With Plate III.]

[Read before the Royal Society of N. S. Wales, August 7, 1912.]

Introduction.

With the increasing interest shown by geologists generally in the origin of topographic forms in Australasia, it becomes more and more a necessity to have an accurate model of the continent prepared by means of which to test the value of the various hypotheses put forth to explain the origin of the present topography. Only after a detailed topographic survey has been made will such a model be obtainable. In the meantime it is helpful to have figures which represent somewhat correctly the larger topographic features of the continent.

To supply this need, various models and maps have from time to time been prepared by Australian geologists. Of these, that of Lake George and the Federal Capital Site by T. Griffith Taylor, of Australia by Professor David and W. K. McIntyre, of New South Wales by T. Griffith Taylor, of the Warrumbungle Mountains by Dr. H. I. Jensen, of the Adelaide Region by W. N. Benson, and of the Jervis Bay, Upper Shoalhaven and Nepean Region by L. F. Harper, may be mentioned. That by David and MacIntyre illustrates the broad relations existing between East and West Australia on the one hand, and between Australia and the adjacent oceans, on the other. The models of Harper, Taylor and Benson are fairly accurate representations of the topography of very limited areas of the continent.

The model under consideration is an attempt to represent the main relations existing between the plateau and the adjacent Coastal Area on the one hand, and between the plateau and the adjacent Inland Plains on the other. The usefulness of the model is limited, because of the necessary distortion of the Vertical Scale as compared with the Horizontal Scale, the Vertical element being ten times that of the Horizontal. By this method, all topographic details have had to be neglected, only the main valleys and hills being capable of representation.

The great area of unreduced plateau and the wild nature of the topographic forms linking it to the Coast and the Inland Plains are well shown. The explanation of the isolation of New England from the coast as regards communication, and of the apparently capricious detours of the Great Northern Railway, as shown on an ordinary map, is also afforded by a glance at the figure. The impossibility of the closer settlement of the areas bounding the plateau along its eastern margin is also obvious. Closer settlement has been proposed for these mountain fastnesses, but it is doubtful if this will ever be brought about. At most it will support only a scattered population ; as similar regions in Europe and America—areas of dense population—are almost uninhabited save by pastoralists, miners and timber getters. This does not apply, of course, to the magnificent lands of the Tweed and the Richmond, or to the "bottoms" of the Clarence, Macleay and Manning Rivers. The Inland Slopes of Eastern Australia, however, of which a detail is supplied in the model, form one of the most magnificent expanses of agricultural land in the world. They are due to the denudation of the plateau basalts and Palæozoic rocks —and to the redistribution of the products of such denudation to the west of New England—by the great inland rivers of the continent. The model illustrates this moun-

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tain or plateau destruction and the contemporaneous plain building to the west.

Acknowledgments.—Although the writer is responsible for the main portion of the model, nevertheless, he is under a deep obligation to Mr. R. H. Cambage, Mr. Statham and Dr. W. G. Woolnough, for supplying information without which the model could not have been presented satisfactorily. Thus Mr. Cambage supplied the information from which the Nandewar and the Goulburn River areas have been figured, while Mr. Statham furnished accurate sections, prepared for the Public Works Department, dealing with the areas from the head of the Tweed to Lismore, from the Dorrigo to the Orara River and along that stream, and from Grafton to Glen Innes. Dr. Woolnough also furnished information concerning the Tweed and Richmond areas.

The writer desires to return cordial thanks to Mr. J. W. Turner, Superintendent of the Sydney Technical College, for the preparation of casts of the model to be supplied to the Departmental Museum, the University and the Federal Meteorologist, and to Mr. A. W. Gullick, the Government Printer, for the block for the plate illustrating the present note.

The Model.

1. Scale of Model.
2. Geographical Notes.
3. Biological Notes.
4. Economic Notes.

1. *Scale of Model.*—The horizontal and vertical scales are not alike, the former being 16 miles to the inch and the latter 8,000 feet to the inch. By this method the model can at most furnish an approximate idea of the real nature of the New England topography, inasmuch as only the larger "facts of form" can thus be represented, the vertical element being so distorted that there is no opportunity to represent details. Thus the rivers and their main tribu-

taries are illustrated by the model, but the gulleys and gorges innumerable which break up the continuity of the great cañon and mountain walls are not shown. Similarly, only the larger hills and mountains are represented, the legions of smaller elevations being merely indicated by a generalised type of mildly roughened topography. Accuracy of representation can only be obtained after the completion of detailed topographic surveys.

The general appearance of the New England surface, as gained from a commanding eminence, has, however, been illustrated, as also the general appearance of the wild eastern topography afforded to the traveller as he surmounts the ridges which swell out from the ravines. In the model the cañons and ravines are represented as limited in number, whereas, in reality, the traveller is overwhelmed by the wealth of branching ravines and overlapping spurs as he views the jungle-laden depths from some forest-clad spur or eminence.

2. *Geographical Notes.*—The main topographic divisions illustrated by the model are the great Plateau of New England, the Coastal Region and the Inland Plains.

(a) *The Plateau.*—It is evident that the plateau must formerly have had a much greater extension than it possesses at present. The portion untrenched by cañons and ravines consists mainly of a gently warped and a maturely-dissected surface, above which, in various localities, rise other small plateaus. At the heads of the Namoi, the Macleay and the Manning Rivers, the general plateau surface is almost 4,000 feet in height, thence towards Armidale it possesses a very gentle dip. At the latter locality the plateau has a general height of about 3,500 feet, while the average height of the broad mature valley bases, which mildly roughen this level, is about 3,250 to 3,300[1]

[1] All heights unless otherwise specified are referred to mean sea level at Sydney.

feet. A few miles north of Armidale a plateau surface, similar to that around Armidale, rises rapidly to a height of 4,300 feet, with residuals as high as 5,300 feet on its eastern margin, and this surface is warped very gently to the north and west, but maintains its horizontality to Guy Fawkes, whence it descends rapidly to the coastal area by means of almost impassable gorges.

Certain most interesting forms occur in northern New England, in the central portion of the Macleay Basin, at the head waters of the Gwydir (between Bingara, Bundarra, Uralla, Elsmore and Tingha), along the Namoi near Bendemeer, and along the Manning in the vicinity of the Barrington and Gummi "Tops." A brief mention of such of these as occur in the Tenterfield district may be made as they are typical of all the other areas. All occur in the plateau region proper. Here in Northern New England one finds a great wealth of siliceous granites (72 – 78% silica) associated with basic granites (64 – 70% silica), claystones, tuffs, and very siliceous porphyries and rhyolites (72 – 80% silica).

The acid granites occur as small and large bosses and stocks, and as bathyliths. The porphyries appear to occur as large Palæozoic flows. The claystones and allied sediments are of Permo-Carboniferous Age, in part probably of Lower Marine, Greta, and Upper Marine age. The granites are intrusive into these latest Palæozoic sediments, and they appear to belong to the period which closed the Palæozoic sedimentation in New England.

It is an interesting fact that in the regions containing the acid granite bathyliths and large bosses the *general* or *lowest plateau* level[1] is very limited in area and consists

[1] Known as the Stannifer Level of *northern* New England and the Sandon Level of the *southern* New England in previous reports of the writer. Both are merely parts of the one continuous level.

of broad shallow valleys excavated in the more basic members only of the series, being connected with broad upland valleys and plain-like surfaces in the less resistant rocks in the vicinity. In the more acid members of the granites, the Stannifer level is confined to narrow, mature valleys or even to gorges at the extreme head-waters. At times also this trangresses the margin of the acid granites. The average height of the level is about 3,250 feet, and of its more central mature valleys about 2,900 or 3,000 feet. Tenterfield and Deepwater lie on such mature valley bases excavated in the general level of the Stannifer Plain. About 200 or 300 feet above this, say at an average height of nearly 3,600 feet, distinct traces of another but dissected level are common. Examples of such residuals are the Main Mole Tableland, the plateau west of Bungulla Siding, Poverty Point, Boonoo Boonoo, and other places. Above these levels again rise other fairly large sub-horizontal areas varying from 3,750 to 4,000 feet in height, and such areas may be seen near Tenterfield, Bolivia, the head of the Deepwater River and from the Cataract River towards Wallangarra. A fine example occurs between the 9½ and the 11 mile pegs on the Tenterfield-Wilson's Downfall Road. Another is suggested by the presence of accordant summits rising above the 3,600 feet level in the neighbourhood of Mount Mackenzie at Tenterfield. Above these sub-horizontal surfaces in the larger acid masses again rise other points varying in height from 4,300 to 5,000 feet. Such are Mount Mackenzie (4,300 feet), Bald Rock (4,400 feet) in the acid granites, and Mounts Jondel, Bajimba (5,000 feet), Capoompeta (5,000 feet), Spiraby (5,100 feet), and Cooloomangera in the acid porphyries, a little to the east of Bolivia. Owing to their relatively small area and the distortion of the vertical scale, these various levels, higher than the Stannifer and the Sandon levels, are not clearly shown on the model.

So striking are these features in New England that it would almost appear as if the development of the Sandon and Stannifer Level had been carried on to a certain stage for the sole purpose of leaving the more acid stocks and bosses in striking topographic relief. In fact, a rough geologic map of the acid plutonics and volcanics could be sketched easily on a contour map, the higher portions indicating the positions of the acid rocks. Nevertheless, the various levels are separated from each other by youthful topography, or rather, the Stannifer Level is connected to the higher levels by youthful forms. At one time the writer was led to believe that the scarps and gorges of the higher levels represented the action of erosive activities on fault blocks uplifted in late Tertiary Time above the Stannifer Level, but after careful examination the faulting hypothesis had to be completely abandoned, as there was direct proof to the contrary. On the other hand, differential erosion is sufficient to explain the phenomenon. Nevertheless, the mind is almost overwhelmed in the contemplation of such relative rock strength as is evidenced by the apparent indifference of acid granites and massive rhyolites to erosive activities. If New England had been composed of ordinary claystones, slates, and allied rocks, there would have existed little or no trace of levels older than the Stannifer or Sandon, and the geographer would have had no clue as to the Mesozoic and the earlier Tertiary History of New England, except by inference from the sedimentation in adjacent geographic regions. On the other hand, the disposition and extent of these older levels indicate that the periods of time during which the peneplains under consideration were successively formed in New England became decidedly less and less, while the vertical movements grew more pronounced as the cycles became less in duration. Thus the 4,000 – 4,300 feet level amounted almost to complete planation, only a few felsite

and acid granite peaks being left. The level from 3,700 – 3,800 feet marked a cycle of erosion only slightly less sweeping in its action, while the 3,500 – 3,600 feet level left masses which are of considerable length and from one to two miles in width. The cycle of erosion which produced the Stannifer level (3,250 - 3,300 feet) was so short that it accomplished very little real work in the resistant acid rocks, while all work of later date has been confined to a continued rejuvenescence of movement during which the peneplains have been lifted vertically for several thousands of feet in the neighbourhood of the Main Divide, while mature valleys first and then ravine-within-ravine forms have been excavated in the uplifted block or blocks.

These acid rocks appear to form buttresses right round New England. The highest land occurs mainly to the east of the present Main Divide, because here the acid rocks have their greatest development. In the northern half, the north and south lines of the longer granite axes form a great ramp to the east. The long plateau peninsulas of Guy Fawkes, Tingha, and the Barrington and Gummi Tops owe their existence also to the presence of huge granitoid bosses.

It is difficult for the geographer who does not know New England to credit the existence of these residuals of topographies older than the present plateau surface, because in most extra-New England areas in New South Wales the acid or tin granites are subordinate in importance. Where there exists tin in abundance in Eastern Australia (with the possible exception of Mount Bischoff) there will acid granites also be found in abundance, and there will be found these Mesozoic (and early Tertiary ?) levels.

Faults and warps of the Plateau.—The conception which harmonises most with the facts of observation appears to be that the main New England plateau surface was

developed by erosive activities near sea-level, and that it has since been raised unevenly, so as to form a warped and faulted surface. The great Ben Lomond-Guyra-Guy Fawkes-Plateau is best explained as a faulted or warped portion of the Sandon Level. It cannot be explained satisfactorily as a residual of erosion, because the general rock types composing its mass are not harder than those of the associated lower areas, and, moreover, the main streams head in the higher block and yet flow in relatively narrow valleys, although the smaller tributaries in similar structures lie in relatively broad valleys. The great Dundahra and allied scarps may be due either to faulting or to differential erosion.

(b) *The Coast.*—The plateau is connected to the coastal region by rugged and youthful topography. This feature is well illustrated by the model. The coastal region consists, in the main, of structures weaker than the acid granites, porphyries and rhyolites. Along the Namoi, Peel and Hunter Rivers, this relative structural weakness is particularly emphasised. The model indicates the geographic youth of the eastern edge of the plateau. Nevertheless, the age of the wild topography is doubtless to be measured by millions of years, for all the ravines in the granites have been formed by headward recession of the streams, yet not one waterfall lip in the granite country has receded to the extent of an inch during the last twelve years according to the writer's observations, although heavy floods have occurred along these watercourses during such period. On the other hand, the gorges have receded for many miles through granites, and this also after the close of the first division of the Cañon Cycle. The Hunter Valley, long and wide as it is, is only as old as the Macleay gulches, and these in turn are as old as the cañons of the Clarence and the Bellinger. The explanation appears to

be somewhat as follows:—The Hunter River structures, although Palæozoic, are relatively weak, while the Macleay gorges were held up for a long period in the acid Carrai granites; once the Macleay had receded westward of these powerful structures, it advanced rapidly through the slates, until in turn it encountered the granites in the central plateau. In all cases the acid granites are situated in those localities where they are best protected from erosion, and this not by accident, but by a beautiful selective action exercised during several cycles of erosion. Thus, when the granites were first exposed, the streams avoided them as much as possible, because of their strength and insolubility, leaving them in the main inter-stream areas as the cycles progressed. Gradually they thus became localised as head-waters. Each successive slight uplift merely accentuated the process; until at present they are practically indestructible. The strike of the New England structures, moreover, is characteristically meridional in disposition, and the granites appear to have followed main meridional lines of weakness in the earth's crust. This has had a peculiar reaction on the course of the Eastern Australian streams. To take a single example:—The Clarence River in its early history made long subsequent courses so as to avoid attacking the north and south acid granites lying farther west. As the successive cycles of erosion resulted only in incomplete reductions to peneplains, so these *subsequent* stream forms became accentuated. Upon the great Kosciusko Uplift the streams were rejuvenated and the cañons still receded along the edges of the acid granites. In this way has also arisen the widely varying topography of the same stream along its lower course and along the great granite ramps farther west.

Similar subsequent courses may be studied along the Myall, Karuah, Paterson and Williams Rivers. Here, however, rhyolites take the place of granites. It is probable

that a study of the Hawkesbury, Shoalhaven and other streams may reveal histories similar to those of the Clarence, the Namoi, and the Peel.

Another interesting feature may also be mentioned in connection with these coastal streams. Whether mature or youthful, they form "valley in valley" types. (The western streams also exhibit the same feature). It is as if the Stannifer (and Sandon) Peneplain surface had been elastic, and, under periodic pressures, has swelled upwards at several distinct periods, but so slowly as not to deflect the streams from their main courses. This explains the apparent anomaly of long north and south streams flowing near the coast and turning suddenly to the east to enter the sea. For the dense Palæozoic structures had a general north and south strike, to which, as mentioned already, the acid granites formed no real exception. During the peneplanation stages the weak structures were gradually occupied by the streams, and the latter found it increasingly difficult to cross the strike of the country. Upon the late and great Tertiary Uplifts the streams found it easier to follow the old channels than to carve new tracks across the country grain.

(c) *The Inland Plains.*—These have had a history very similar to those of the coastal area. The western flanks of New England are of Devonian and Carboniferous rocks which proved to be relatively weak structures, and were easily stripped from the more central granites. This is well seen by a study of the model in the area drained by the Gwydir, Namoi, Peel and Hunter Rivers.

Biological Significance.

The model tells its own tale to biologists. In late geological time the present plateau surface was several thousands of feet lower. At that time there was no plateau worthy of the name, a plain raised but little above

sea level and dotted over with residuals, never exceeding 1,700 feet in height, extending across the area. From the coast to the inland plains three distinct climates now exist where there was previously only one. This revolution in the climate appears to be no older than the early or late Pliocene, thus many peculiarities of the fauna and flora are due to influences having no greater an extension in time than that of Pliocene or Post Pliocene. Previous to the last complex movement of uplift, the history of the area was one of long continued stable equilibrium near sea level.

Economic Significance.

Communication.—The model illustrates well the difficulties encountered by the pioneers in attempting to reach New England. It must be remembered also that this country of ravines bordering the plateau on the east is clad in dense jungle growths, which contain little or no edible vegetation.

The reason for the disposition of the main roads and railways is also shown. The position of the Main Northern Railway is seen to be not nearly so dangerous from a military point of view as some imagine, as it is protected by the wild and rugged plateau falls.

Settlement, Eastern Side.—In this plexus of gorges there is no hope of settling many people, because each family would need from 5,000 to 7,000 acres for comfortable support. On the other hand, relatively small areas of densely watered basaltic and other areas such as those of the Tweed and the Richmond, and the lower valleys of the Clarence, Bellinger, Macleay, Manning and other streams are excellently adapted for purposes of close settlement.

Plateau.—A large portion of the plateau is of poor nature and not adapted for purposes of close settlement. Exceptions, however, are the basaltic areas of Dorrigo, Guy Fawkes, Glen Innes-Inverell and the Guyra-Ben Lomond

area, and the sources of the Namoi, Peel, Macleay, Manning and Hunter Rivers.

Western Slopes and Plains.—These consist of excessively fertile slopes and plains of chocolate, red and black soil. These have been derived from the denudation both of the New England basalts and the fertile Devonian and Carboniferous tuffs.

The writer believes that here will be large centres of population in the future, as a knowledge of the produce adapted to the climatic and soil conditions of this vast area is alone needed for success.

Note on some RECENT MARINE EROSION at BONDI.

By C. A. Süssmilch, F.G.S.

[With Plates IV - VI.]

[*Read before the Royal Society of N. S. Wales, September 4, 1912.*]

On the 15th July of this year (1912) an unusually heavy sea, caused by a storm some distance away in the Tasman Sea, did considerable damage to jetties, breakwaters, retaining walls, etc., along the coast of New South Wales. Some very striking results were produced at Bondi by the waves during this storm and are worth recording. In Plate IV is shown a huge block of sandstone thrown up by the waves at the foot of the headland on the northern side of Bondi Bay near Sydney. This block measures approximately 20 feet long, 16 feet wide and 10 feet high; it has therefore a cubical content of 3,520 cubic feet, and assuming that 15 c. ft. of sandstone weigh 1 ton, its total weight must be about 235 tons. It was situated originally at the

seaward end and formed part of the bed of sandstone upon which it now rests. Its original position is shown by the $\times$ in Plate V. Its rectangular shape is due to the existence of two set of joints, approximately at right angles to each other, in the sandstone bed to which it previously belonged. Wave erosion, while it was still *in situ*, had widened these joints, and thus separated it form the bed as a whole; the presence of marine growth over much of its then under surface shows that it was not rigidly joined to the underlying stratum immediately prior to its removal.

To reach its present position it must have been elevated through a vertical distance of at least 10 feet, and then carried along a horizontal distance of about 160 feet. While in transit it must have been turned completely over, for it is, as shown by the marine growth, now resting upon what had been its top before removal.

Mr. E. C. Andrews, B.A., has made the following calculation as to the power necessary to lift this block of sandstone through a vertical distance of 10 feet in one second. As it was lifted over a nearly vertical face, it may be assumed that it was lifted in one act, and that the time taken was not more than one second.

Assuming that the specific gravity of the sandstone is 2·5 its weight in water would be only $\frac{3}{5}$ of its weight in air,

$$\therefore \text{ weight in water} = 235 \text{ tons} \times \tfrac{2}{3} = 135 \text{ tons};$$

the vertical height lifted being 10 feet,

then $135 \times 10 = 1350$ foot tons necessary to lift the block,

$$\therefore \text{HP} = \frac{1350 \times 2240}{550} = 5498.$$

One end of this sandstone block was broken off during transport and carried several hundreds of feet farther to the west.

Many other illustrations of the power of the waves during this particular storm may be seen in the same locality. In

Plate VI is shown other boulders of sandstone transported and broken by the waves. These, in their present position, are on a shelf 6 to 10 feet above high water mark and some 200 feet from its edge. The one marked A is a remnant of a much larger block, and still weighs from 15 to 20 tons; the white surfaces shown in the photograph are all fresh surfaces produced by the breaking off of large portions, one of which is shown at B. This fragment alone weighs about 8 tons, and behind it there are others not visible in the picture. The white scars on the adjoining masses of sandstone give eloquent testimony of the way in which they were battered by A and B being hurled against and over them by the waves. Similar effects are in evidence at many other points, and to any one familiar with the locality it is obvious that more marine denudation was accomplished above high-water mark during the few hours of this one storm than the cumulative results of many previous years.

The writer has been a frequent and regular visitor to this and other parts of the coast near Sydney during the past fifteen years, but never before has he seen anything approaching in magnitude the work of wave erosion during this particular storm. It affords ample testimony of the correctness of the principle enunciated by Mr. E. C. Andrews, B.A., that it is the infrequent great storm wave which is the main factor in producing coastal erosion, just as it is the infrequent great flood which is the main factor in river erosion.

The great boulders transported and broken by the storm of July 1912, will probably rest peacefully in their present position for many years, until another wave arrives of sufficient magnitude to again disturb them from their present position. The photographs used in the illustrations were taken by Mr. J. W. Tremain.

Explanation of Plates IV, V, VI.

Plate IV.—A boulder of sandstone weighing 235 tons, lifted into its present position by wave action at Bondi, N.S.W.

Plate V.—The same boulder as shown in Plate IV, viewed from the cliff above and showing the place (×) from which it was moved.

Plate VI.—Some effects of wave action at Bondi, N.S.W.

BEACH FORMATIONS AT BOTANY BAY.

By E. C. Andrews, B.A., F.G.S.

With Plate VII.

[*Read before the Royal Society of N. S. Wales, October 2, 1912.*]

CONTENTS.

Introduction.

The literature dealing with wave action and beach formation is voluminous. The names of Cialdi, G. K. Gilbert, De la Beche, Elie de Beaumont, Scott Russell, Sir G. Stokes, Sir G. Airy, Rankine, Stevenson, Fenneman, Gulliver, Vaughan Cornish and others rank high in this connection. Some of the reports of these authors are written in technical language and are unintelligible to the uninitiated. For the latter the lucid and brief explanations by G. K. Gilbert,[1] Fenneman,[2] Gulliver,[3] Vaughan Cornish,[4] D. W. Johnson,[5] and T. Steel,[6] should be very helpful. In "Beach Cusps," by D. W. Johnson, will be found an excellent epitome of the literature dealing with these interesting shore-line features, besides being in itself a distinct contribution to the theory of Beach Cusps.

The present note is not of a controversial nature, but is an attempt to apply the inductive method to the theory of beach origins.

Believing that the simple statement of a case often amounts practically to an explanation, the writer has adopted the narrative style in the body of the present report, relating the peculiarities of waves and of beach forms as observed on one beach during a period extending over about three years (1909 – 1912) so as to make the significance of the observations apparent by a mere recital of the sequence of forms perceived. It will be seen, as these pages are read, that the peculiar forms observed

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[1] Topographic features of Lake Shores. Fifth Annual Report, United States Geological Survey, pp. 75 – 100.

[2] Lakes of South Eastern Wisconsin. Wisconsin Survey, 1902, pp. 13 – 30.

[3] Shore Line Topography. Proc. Am. Acad. Arts, Sci., xxxiv, 1899.

[4] Sea Beaches and Sand Banks. Jour. Royal Geol. Soc., 1898, pp. 528 – 543; pp. 628 – 651.

[5] Beach Cusps. Bull. Geol. Soc. Amer., Decr. 1911, pp. 599 – 623.

[6] Presidential Address. Proc. Linn. Soc. N.S.W., 1905, pp. 622 – 625.

during the period mentioned could scarcely have been deduced from a mere knowledge of wave and current action as contained in the text-books. It is also evident that he who would understand the origin of the so-called beach "cusp" or scallop must understand the origin of the beach itself.

Thesis.

The beach cusp is a form due to the interference of water undulations or pulses, and is a temporary feature illustrating the methods adopted by water undulations either in excavating or in building one beach adjusted to their own strength out of another beach not adjusted to their strength.

Physical Features of Botany Bay Locality.

The main features of Botany Bay and district are shown on the accompanying map (Plate VII). The maximum width of the bay is between five and six miles, and the maximum length is about eight miles. The heads connecting the inlet with the South Pacific Ocean are about 1,500 yards wide at the narrowest point. Lady Robinson's Beach has a length of five miles. It consists of several large flat curves facing the heads. Sandy forelands compose the northern and southern extremities of the beach and the beach itself stretches uninterruptedly from the two tidal streams of George's and Cook's Rivers which discharge into Botany Bay. Of these, the former is by far the larger stream, but each for miles above its point of discharge into the bay is tidal, and it is doubtful whether the fresh-water content of these streams is ever as important as that of the tidal stream.

The bay is shallow, a maximum depth of about fourteen fathoms occurring between Cape Banks and Point Solander. About three fathoms is the average depth. The spring and neap tides have vertical ranges of 5 feet 6 inches and 3 feet 8 inches respectively, with a maximum and minimum

Owing to a mistake on the part of one of the editors (J.A.P.), the following corrections are required to the paper on "Beach Formations at Botany Bay," by E. C. Andrews, B.A., F.G.S.

Page 161, line 12, for "*miles an hour*," read *miles a minute.*
,, 170, ,, 19, for ,, ,, ,, ,, ,,
,, 170, ,, 26, for ,, ,, ,, ,, ,,
,, 171, ,, 13, for ,, ,, ,, ,, ,,
,, 172, ,, 1, for "*yards a minute*," read *yards a second.*
,, 180, ,, 29, for "*minutes*," read *seconds.*
,, 181, ,, 2, for ,, ,, ,,
,, 181, ,, 13, for "*miles an hour*," read *miles a minute.*

The speed referred to is the velocity along the shore line of the intersections of the waves with that line.

[To face page 161.]

range of 6 feet 9 inches and 3 feet 3 inches respectively. For this information I am indebted to the courtesy of Mr. G. H. Halligan, Hydrographer to the Public Works Department. A southerly current[1] flows at a distance of a few miles from the coast, and the average velocity of this current varies from one mile to two miles an hour. The heavy *on shore* gales come from the east and south-east directions, and the great rollers thus generated pulse from the ocean into the bay through the heads and strike the northern point of the beach first, thence they travel southward along the beach at an average rate of from three to six miles an hour. This wave motion is not regularly as from north to south, but is broken slightly at the horn of each cusp, thus causing the waves often to reach the shore in a series of pulses arranged approximately *en echelon.* Generally speaking, however, the waves travel fairly regularly along the beach from north to south.

The beach is of fine sand. No cobbles or boulders are thrown up on the beach except during record gales, say, only once (July 1912) during the last thirty years at least. In intertempest periods the cobbles lie buried in the sand.

Behind the present beach lies a narrow belt of sand dunes reaching a general height of twenty-five feet above present low water mark. A series of beaches and lagoons lie between the present beach and the Trias-Jura sandstones and shales which formed the edge and base of the bay when it was more extensive than at present. The beaches of the series just mentioned reach a general height of from 17 to 20 feet above low water mark. On Plate VII and Fig. 1, the main features of these beaches and lagoons are shown.

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[1] C. Hedley. Presidential Address. Proc. Linn. Soc., N.S. Wales, 1910, p. 9. G. H. Halligan. Sand Movement along the Coast of N. S. Wales. Proc. Linn. Soc. N.S.W., 1906.

The alluvium and sand ridges are indicated by stippling on the map. The boundaries of the alluvium have been taken from a map of the Sydney alluvial areas by Mr. M. Morrison of the Geological Survey. *AB* represents an inshore bar between two old sandstone headlands, while behind this is a low lying area of black soil drained by Muddy Creek and utilised for market-garden purposes. Sixty years ago this area now occupied for market gardens was a swamp flanked by the sandridge *AB*. On the sand-ridge pioneers built their homes, while they drained the swamp area and protected their gardens from inundation by building low dykes both parallel, and at right angles, to the course of Muddy Creek. *CD* is a long flat ridge of sand whose trend rudely sympathises with that of the present beach and the ridge *AB*. Inshore of *CD* is a low lying area of swampy land formerly known as Pat Moore's Swamp and a former home for numerous wild fowl, but now drained in great measure. The broad sand ridge *CD* is quite a feature in the low-lying landscape and it rises steeply for 15 or 17 feet from the swampy area to the west. The topography thence to the present Lady Robinson's Beach is in contrast with the alternation of swamps and sand ridges just described to the west. Between *CD* and the present beach numerous parallel ridges of sand occur, without any intervening swamps and lacking the persistent north and south direction of the ridge *CD*. All the ridges have accordant summits and the long shallow intervening troughs are all on an approximate level. A bird's-eye view of the ridges and hollows from a point several hundred feet above them would give the appearance of a plain covered with dense timber and scrub growths. *Eucalyptus pilularis*, *E. botryoides*, *E. robusta*, *Banksia integrifolia*, and *Angophora lanceolata* are the common larger plant growths of the sandy waste, while *E. robusta* and *Casuarina glauca* are the common large growths of the swampy areas.

A whole series of bay bars below low water mark occur from 200 to 1,000 yards away from the present beach. During the great storm of July 1912 these bars appeared to be disposed parallel to the present beach, as evidenced by the parallel lines of heavy breakers. To the casual observer such bars are only apparent during great storms such as those of 1889 and 1912.

The accompanying transverse section is an attempt to explain the character of the bars and swamps.

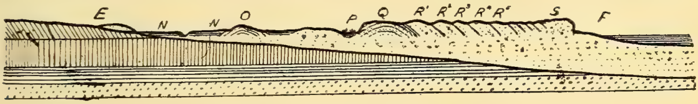

Fig. 1.—*Section across old Bay Bars along section EF on Plate VII.*

E—Sand dune on old shoreline. NN—Swampy ground drained by Muddy Creek. O—Small bay bar (AB on Plate VII). P—Pat Moore's Swamp. Q—Long high bar (CD on Plate VII). $R^1R^2R^3R^4$*—Old bay bars. S—Present line of sand dunes. F—Sea level.*

History of Area immediately prior to Formation of Present Beach.

It would appear that the site of the present Botany Bay was occupied in early and middle Tertiary time by horizontally-bedded Trias-Jura sandstones and shales. In late geological time a wide shallow valley was excavated therein by the conjoint action of George's and Cook's Rivers, which effected a junction somewhere within the area now occupied by the bay. It would appear also that for some reason the ocean overflowed into this stream-formed valley, submerging it in places to a depth of 200 or 250 feet, as suggested by analogy with neighbouring areas.[1] An enormous amount of silting was then accomplished by the

[1] One of the Hawkesbury Bridge piers is sunken about 200 feet in the river silt only about seven miles above the stream mouth.

T. W. E. David and G. H. Halligan. Evidence of recent submergence of Coast at Narrabeen. This Journal, 1908, pp. 229 - 237. T. W. E. David. Anniversary Address to the Royal Society. This Journal 1896, p. 57.

action of the George's and Cook's Rivers when in flood, and with the progress of time, either aided or not by this action, the storm waves pulsed through the heads and formed the bay bar *AB*, tying together two headlands in the bay in the manner suggested by the section (Fig. 1). Simultaneously the main bay bar *CD* was formed farther out in the bay as a result of repeated gale action. These ridges gradually increased offshore by means of parallel growths during record storms. But between the shore-line and the bars *AB* and *CD*, long strips of relatively deep water remained. It is probable that none of these bay bars ever reached the surface of the bay.

During recent historic times these sand bars and flats emerged from the bay to an average maximum height of 16 – 20 feet above low water mark. By silting action, after the emergence of the bay bars as dry land, the interbar areas became converted into swamps, while Muddy Creek, breaking through the sand bar *AB*, kept this portion within tidal influence.

The argument for the subaqueous as opposed to the sub-aerial origin of these forms is based on the peculiar disposition of the sand ridges and swamps, these lying approximately parallel to the present beach, and not at right angles to the direction of the dominant winds, the persistence in length of the main bars and the general accordance of the sand ridge summits. If of aeolian origin the bars should be rather in the form of dunes pointing to the north-west or north-north-west, they should be much less regular and much more massive and they should not possess such accordant summits as the forms under consideration.[1]

An examination of other low-lying plains of sand in the Sydney district tends to strengthen this opinion. Thus the

[1] G. H. Halligan. Sand Movement on the New South Wales Coast. Proc. Linn. Soc. N.S.W., 1906, p. 621

large sand flat which the Northern mail-train passes over near Woy Woy is a case in point. This area lies about 10 feet above high tide mark; it is in such a sheltered position that it cannot be explained by the action of wind; it has no sign of dune structure; and, in company with the numerous similar occurrences around Sydney it is covered with forest growths. At Bondi the combination of the two types may be seen. The low-lying area separating the harbour from the ocean at this point is seen to possess a base consisting of a sand flat, while its eastern or seaward portion may be seen to be buried under high sand dunes of wind origin.

In all these topographical features it is the "element of horizontality" which is so marked a feature. On the other hand, this element is lacking in the marginal sand hills which are known to be of wind-blown origin.

Present Beach Features.

The general sweep of Lady Robinson's Beach is broken by several flat cuspate forms. The longest curve between cusps extends from the mouth of Cook's River to President Avenue, a distance of two and a-half miles. This portion is exposed to the heavy waves pulsing through the heads. Hence traced southwards the succeeding cusp is a mile distant, while the remaining mile, or thereabouts, of beach to Doll's Point is formed by a couple of small cuspate forms. In the experience of the writer, the main outlines of these large curves are preserved even during the heaviest gales. A current generated by the wind and storm waves appears to travel along the beach during heavy storms.

Frequent features of the beach are the peculiar scalloped forms (Figs. 2 and 7), of variable size and shape, to be seen during periods of changeable weather. No consensus of opinion as to their origin appears to exist among geologists and geographers, and with a view of ascertaining the

significance of these and allied features, the writer made a great number of observations on Lady Robinson's Beach during the years 1909, 1910, 1911, and 1912.

In Johnson's "Beach Cusps"[1] is given a summary of the opinions of previous writers on this subject. Johnson himself explains the origin of the scallops as follows:—[2] "Selective action by the swash develops from initial irregular depressions in the beach shallow troughs of approximately uniform width whose ultimate size is proportional to the size of waves, and determines the relatively uniform spacing of the cusps which develop on the inter-trough elevations."

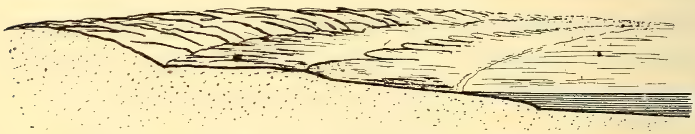

Fig. 2.—*General appearance of Lady Robinson's Beach before gale of July* 1912.

Vaughan Cornish[3] in "Sea-beaches and Sand-banks" discusses the profile of equilibrium for the beach, and mentions that the greater the wave, the greater the strength of the back-flow. "In a given locality, the regimen slope of beach proper to a rough sea is not so steep as that for a quiet sea."

"As the size of the breakers increases, the wash tends to make the slope less steep. Neither the force nor the resistance are absolutely uniform along the shore, so that this action commences at selected places. From the moment that even the shallowest grove is thus formed, the backwash finds its way to sea almost entirely by this path. The discharge of the breaker continues, however, to send

[1] Bull. Geol. Soc. Am., Dec. 1910, p. 599. [2] *Ibid.*, p. 620.
[3] Jour. Royal Geol. Soc., 1898, p. 536.

the on-wash up the ridges as well as up the furrows. Sand, therefore, is still deposited on the ridges, which may continue to increase in height while the absolute level of the troughs may be lowered, and the amplitude from the crest of the ridge to the bottom of the trough necessarily increases. In this way is produced that succession of ridge and furrow at right angles to the sea front."[1]

The present writer believed that by multiplying the observations convergence of light would be brought on to the problem of beach origins. With this in view numerous observations were made during a period of three years, the fundamental conception held at the outset being that the great storm determines the main beach outlines,[2] and that the scallop marks a temporary disturbance of the profile of

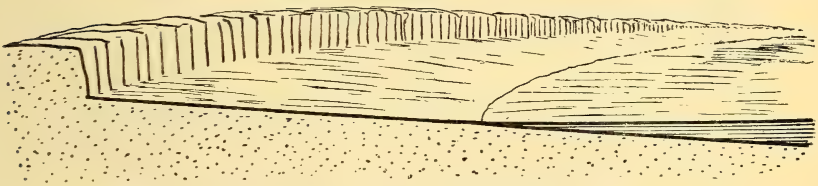

Fig. 3—*General appearance of storm beach of July* 1912.

equilibrium for the beach. For the sake of simplicity of presentation the narrative style is adopted in describing the observations, and it will be seen that the simple statement of the more important observations amounts practically to an explanation of the forms.

1909.—A storm produced a wide, smooth and cuspless beach of gentle slope.

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[1] Vaughan Cornish, *Ibid.*, p. 639.

[2] E. C. Andrews. The Geographical Significance of Floods, Proc. Linn. Soc. N.S.W., 1907, p. 828.

See, however, G. H. Halligan. Sand Movement on the Coast of New South Wales. This Journal, 1906, pp. 619 - 640. Halligan maintains that the beach outlines are due to the slight southerly current aided by the northerly wind. This is a different view to that taken by the present writer.

The observations made during this storm suggested that the great storm produced the main beach features; that any class of wave action, if maintained unaltered for a definite period, would produce a smooth cuspless beach of certain slope, and that the cusp was a temporary feature imposed upon the beach while the waves of the changing conditions were seeking to establish a profile adjusted to their own strength.

During the period from October 1909 to August 1910 the beach assumed various irregular forms.

August 1910.—A heavy storm produced a wide beach of even and gentle slope. The beach was widened at the expense of the sand dunes in which a small cliff was formed. The writer only saw the effects of the storm some considerable time after its occurrence.

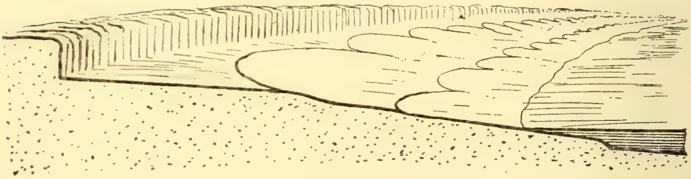


Fig. 4—*General appearance of beach shortly after storm of July* 1912.

1911, July 22nd.—Waves produced by a southerly gale commenced to cut away the remnants of the 1910 storm-beach existing as small ledges under the cliff formed in 1910 in the sand dunes. The erosion formed deep scallops or cusps in the thin strip of the old high beach of 1910. The widths as measured from cusp to cusp in succession were 33, 33, 33, 33, 33, 34, 33 paces. The scallop troughs were excavated as much as three feet below the old beach remnants.

July 23rd.—Wind increasing. Two sets of cusps in alignment and selected at random gave the following successive widths :—

$$\left.\begin{array}{l}30, 30, 30, 30, 30, 30, 30, 30\tfrac{1}{2}, 30\tfrac{1}{2}, 30\\32, 32, 32, 32, 32, 32, 32, 30, 30, 32\end{array}\right\}\text{paces.}$$

The average length of these cusps measured from apex at head of beach to tip of cusp was 14 paces.

In the afternoon at low tide a new beach was seen to have been in process of construction from 20 to 25 feet seaward of old (1910) one. The cusps by this time had almost vanished, and a bench or terrace had been excavated, whose edge was sinuous in plan and corresponding to the blunted cusp points which marked its beginning. The bench was from 12 to 26 inches high, the higher and older bench or beach (1910 beach) being 8 to 16 feet in width (Fig. 5). Wind about 40 to 45 miles an hour. Breakers 10 feet in height.

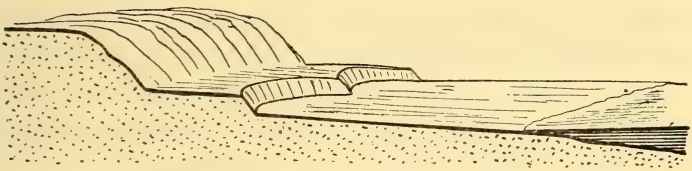


Fig 5.—*Ledge with scalloped front cut in storm beach by heavy swell.*

By 5·30 p.m. the cusps had almost gone and a new platform was being formed below the older one. At the same time the material of the beach so excavated was building up a gentle slope under the water continuous with the profile of the more landward portion of the beach.

July 24th.—The ledge of erosion was carried landwards and showed no cuspate indentations. Only small fragments of the older higher bench left. Cuspless beach formed.

1912, January 5th.—Strong southerly wind succeeding to a period of mild weather.

A cuspless and steep beach produced, about 60 feet in width and about 8 to 9 feet in height. The slope of this profile was convex to the sky in its upper portions. The profile was much flatter at low tide mark and appeared to be concave to the sky.

January 8th.—Wind much milder. Many cusps formed along the southern end of the main middle beach curve. Axes of cusps directed to N.E. and E.N.E. Wind from S.E. to E.S.E. Waves four or five feet high. Cusps 17 to 20 paces apart. There was observable a tendency to form an incipient cliff at high water mark. No cusps seen near low water mark, but rather an even profile sloping up to cusps and inter-cusp hollows. Ridges and furrows about 50 feet in length. In the lee of Lady Robinson's baths traces only of cusps formed.

January 9th.—Wind from north-east. Abundance of cusps on the northern portion of beach. Cusp axes directed south-east. Waves hit shore obliquely travelling along same about four miles an hour.

January 10th.—Observations on southern beach. Strong south wind. Falling tide. All cusps rapidly obliterated and terrace cut in beach formed by north-easter of previous day. Ledge cut 15 inches in height. Upper portion of new beach convex, and lower portion apparently concave, to sky. Wave travelled along shore from north to south at the rate of about five miles an hour. Breaking waves observed to run up beach in successive small waves hitting shoreline obliquely and forming a strong along-shore current from south to north.

January 11th.—Low tide. Strong but decreasing southerly wind during early morning. Distinct ledge formed at limit of waves. Ledge 12 to 20 inches high, breached in places by cusps. Under the ledge fairly steep profile concave to sky, thence to low water mark a flattish

profile convex to sky. This lower convex portion beautifully scalloped with cusps.

During the night a heavier wind had sprung up and piled up the sand seaward of the ledge especially near low water mark. Towards morning the cusps had then been developed under a falling wind.

January 12th.—Tides decreasing, wind moderating, 25 miles an hour from S.S.E. Ledge of erosion cut in the erosion bench of January 11th. This ledge front in plan was notched with slight cuspate indentations possessing successive widths of 20, 20, 20, 25, 25, 25, 25 paces. Cusps almost absent. Breaking wave travelled along-shore from N. to S. at about four or five miles an hour, while each wave instead of continuously breaking approached the shore line in a manner somewhat *en echelon* (Fig. 6), and chased each other *along* the beach before the wind in a direction as from south-east to north-west. The backwash traversed the beach in successive ridges or waves running from W.S.W. to E.N.E. or N.E. forming cusps in the beginning.

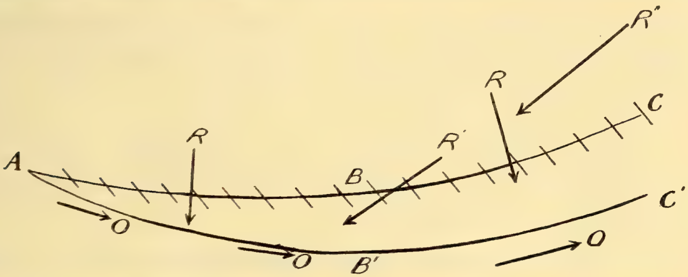


Fig. 6.—*Method of wave approach on Lady Robinson's Beach during heavy cross winds.*

ABC—Wave front. AB'C'—Breaking line. OO—Travel along shore of breaking wave ABC. R—General direction of wave motion. R'—Direction of small cross waves. R''—Direction of wind. Small cross bars along ABC represent cross waves into which ABC was divided.

January 12th–24th.—About January 16th a "black nor'easter" (gale) obliterated all cusps. Breakers travelled

along beach about 100 yards a minute from north to south. Numerous short cross waves formed one roller. Absence of wave pulses marked.

About January 18th a southerly gale (35 miles an hour). Half tide. As tide rose the breaking waves broke up into short oblique waves and ran up and along the beach in a north west direction. Waves appeared to lack definite pulsating movement and were driven one after the other along the beach before the wind. Bench cut nine inches below upper beach.

January 21st.—" Black Nor'Easter." Rollers approaching breaking line seen to be formed of short cross waves arranged approximately *en echelon*. This caused by heavy wind. Cusps speedily cleared from beach. Ledge cut at upper limit of waves in landward portion of beach, ledge front receding up beach as tide rose. Waves travelled from north to south along beach with great velocity.

January 22nd.—Strong wind from south east. Cliff 18 inches high all along beach at high water mark. Erosion profile above and below the small sand cliff, aggradation profile near low water mark. Waves travelled with great velocity along-shore from north to south.

January 23rd.—South-east wind. No cusps. Beach of accumulation. Small step or cliff cut by waves during previous day partly buried.

January 24th.—Small cusps near high water mark. Step or cliff cut by waves during January 22nd almost buried by accumulative action of waves.

January 29th.—Heavy sea subsided. Wind negligible. Abundance of cusps developed. Widths of set of successive cusps:—15, 15, 17, 16, 16, 15, 15 paces.

January 30th.—Strong southerly wind. Cusps demolished. Lower portion of beach aggraded. Step 12 inches

high cut in upper limit of beach. Wide smooth beach of gentle slope produced.

January 31st.—Southerly wind gradually overcome and strong nor' easter set in. Main breaking wave as it approached the beach cut up into small and fairly evenly-spaced waves, which approached shore obliquely and chased each other along beach. Cusps which had been developed during calmer weather of morning now rapidly cleared away. Step formed at upper limit of beach produced by nor' easter.

February 1st.—Calm conditions. Cusps formed.

February 2nd.—Mild to moderate wind from north-east. Cusps formed at and near high water mark.

During this rapid succession of strong winds alternately from N.E. and S.E., it was seen that beaches were built up considerably on the lower or seaward portions and cut down at the upper or more landward portions; that in proportion as the wind was strong and along-shore (that is, in this case, approximately from N. or S.) the main wave front broke on the beach in short cross waves driven along shore in the direction of the wind; that such waves chased each other along the beach producing a current and that cusps became obliterated under such conditions, but that with approaching calmer conditions the beach became cut away on its more seaward portion and built up on its more landward portion. It was noted also that this aggrading and degrading process was commenced and accompanied by the formation of cusps, but that if unaltered in strength for a considerable period the waves would produce a smooth and cuspless beach, except for a slightly indented front as to their upper or landward limits. Moreover the profile of such cuspless beach was adjusted to the strength of the waves. Any alteration in the weather conditions would result in the breaking up of the simplicity of the beach.

Fig. 7.—*Beach profiles, July* 1912.

ABB′CE—Storm profile. ABB′CDFH—Later beach profile.

February 10th - 26th.—Strong wind from south-east quadrant. High, wide and gently sloping beach produced devoid of cusps. Heavy wind disappeared but heavy swell continued. Step 30 inches in height and with indented or cuspate front produced at upper limit of beach by this swell. In plan this step of erosion thus produced gave the appearance of successions of circular arcs.[1] The swell decreasing, a series of beach cusps was formed possessing an average width of about 35 paces, and these developed just seaward of the high step of erosion. A little later another set of cusps were developed lower down the beach, their widths not being so great as those of the more stormy conditions, and their longer axes being shifted a little to the north as compared with the larger ones. A curious feature was the planing off of cusp salients to form broad facets triangular in plan, the bases of the triangles lying parallel to the general trend of the beach and the apices pointing up the beach. A little later such broad triangular facets were observed to be cut up into a couple of cusps as waves and winds decreased. This subdivision of cusps was observed frequently on subsequent occasions (Fig. 8).

During the excavation of the intercuspate troughs it was observed that the material so excavated was carried down the beach by the backwash and piled under the water

[1] Had a step been cut out by the waves associated with a heavy along-shore wind it would have had a fairly smooth front, but being made by a heavy swell (pulse) it assumed a strongly notched or cuspate front.

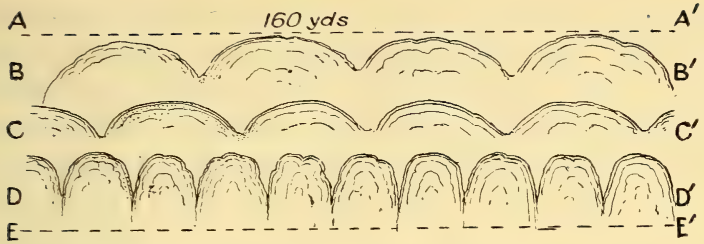


Fig. 8.—*General plan of cusp groups shortly after storm of July* 1912.

AA'—Approximate position of beach cliff. BB'—Cusps formed by decreasing storm waves. CC'—Cusps made by still weaker waves. DD'—Cusps made one week after storm by ordinary waves. EE'—Approximate position of low tide.

near and at the breaking line to form small banks or mounds while opposite the cusp points a local deep remained. Such formations were observed to be associated with simple undulations, in other words, they were formed when the wind was absent or else straight off-shore, the waves thus coming in as smooth swells. At each of these intercuspate mounds near the breaking line the waves would be retarded but deflected from their sides on to the cusp points. Whereas at an earlier period, the waves were accustomed only to interfere along the centre of the intercuspate troughs, at this stage they would frequently interfere at the cusp point itself, gradually cutting it back to a facet and then fashioning it into cusps. Once a system of cusps had been established upon a beach formerly smooth, it was evident that the alteration in shape, size and arrangement of cusps under any prescribed conditions of weather could be forecast. The point still needing explanation was the formation of cusps on a smooth and evenly sloping beach.

February 20th – March 3rd.—Strong wind from south east quadrant produced a wide flattish beach ending landwards in a step cuspate in plan. The wind moderating, a beach ridge was thrown up in front of this indented step

after the repeated formation of cusps of various sizes and patterns. The landward limit of this beach formed a crest higher than the general level of the storm beach upon which it had been superimposed. Gradually a linear series of depressions were thus formed between the cuspate step at the back and the new beach crest in front. Winds and waves increasing, these depressions were converted into waterholes at high tide. The waterholes were approximately cuspate in plan and the water from them returned to the bay in such a manner as to cut up the newer beach into cusps. In a few days these depressions had become silted up and a beach of irregular profile resulted. With rising winds this beach crest was demolished and a flatter profile formed (3/3/12). Thence until July 1912, the beach forms were not nearly so instructive.

July 13th.—Afternoon. Mild weather. During evening wind changed to a half gale from the S.S.E. Moderately large cusps formed on a soft beach. Waves appeared to have but slight "fetch."

July 14th.—Gale from S. to S.S.E. Maximum velocity 51 miles an hour. Velocity up to 70 miles an hour in other neighbouring localities. Cusps produced about 25 paces in width. Waves still apparently of slight "fetch." Well defined cusps about 4 p.m. High tide about 8 p.m. About 6 p.m. the waves began suddenly to advance beyond the limits of the beach formed by waves of normal weather conditions. Well marked cusps however still produced at upper limit of beach. The furrows were those of erosion. Strong grooves also were formed whose general arrangement sympathised with the main outlines of the enclosing cusps. Such deep grooves imposed upon the backwash a plunging motion or succession of short steep waves.

July 15th.—Wind locally off-shore, but tremendous storm evidently blowing on-shore at some distance out to sea.

Waves began to increase in size, but came on beach mainly as swells or pulses. Large cusps still formed at upper limit of beach. Backwash along longer axes of intercuspate troughs very strong with formation of deep wide furrows. Waves gradually growing in intensity.

July 16th.—Wind almost gone, slight off-shore wind. Rollers broke on beach and travelled along-shore from N. to S. with great velocity. Great waves commenced to break from 400 to 1,000 yards off-shore. Heavy bay bar apparently formed off-shore. General appearance of beach and bay much like ocean beach in ordinary storm. Waves advanced on to beach in continually foaming stage. (Such features apparently had not been observed in this bay since the great easterly gale about May 1889). Lady Robinson's Baths and Pier partly demolished—wide flattish beach formed and sand dunes cut back. Cusps gone. Waves dashed on beach tumultuously but advanced with fronts scarcely indented (at half tide). Beach smooth and abnormally raised as to its middle and seaward portions.

High tide about 11 p.m. No wind. Waves at maximum height. Appeared to be 25 feet from low water mark to crests. No sign of cusps. Waves rushed up beach with non indented fronts. Cliff from 8 – 14 feet high cut in sand dunes. Beach smooth, and convex to sky. Large stones torn out of retaining walls up to 120 lbs.[1] in weight tossed like corks along beach from 6 – 10 feet above ordinary high water mark. Stones travelled along-shore for distances aided by currents generated by heavy wave action. At intervals of from ten to fifteen minutes a series of waves much larger than others advanced far up the beach. It was these rare waves which accomplished the whole of the

[1] For description of work done by waves on the ocean beaches in the neighbourhood during this great storm, see Notes on some Recent Marine Erosion at Bondi, by C. A. Süssmilch. This Journal, 1912, p. 155.

destructive work, and to which the formation of the great beach was due. New beach more than 170 feet wide.

July 17th, 7 a.m.—Waves and tides much diminished. Magnificent cusps formed on upper portion of beach. Width apart from 45 to 50 paces. Deep parallel furrows in beach inside cusps. Figures 2, 3, and 4, illustrate the general appearance of Lady Robinson's Beach just before, during, and just after, the storm.

It was evident that this the greatest storm for many years in this locality had piled up a high flattish beach so as to form a bridge along which it could transport its load as a whole with the minimum of work, (hence with the minimum of friction), in its determination to demolish the sand dunes. This implied also a regular profile to the beach. It was also evident that such a bridge was not adjusted to the strength of the diminishing waves, and that such diminishing waves had attempted to form a beach of steeper slope and less width than that of the storm, and that they had commenced the work of beach degradation by the formation or excavation of deep and wide cusps.

July 17th, 5 p.m.—Low tide almost. Beach cut up into fine cusps of successive widths 45, 40, 30, 45, 46 paces. Signs of these cusps becoming smaller and being shifted to the north along the beach and seawards of the earlier cusps. Sets of deep parallel grooves formed inside cusps. Waves in form of swell travelling N. to S. along the beach with great velocity.

July 18th – 31st.—Waves still decreasing in height. Nine cusps formed in front of eight older forms. Later with still decreasing swell a set of cusps formed in front of older sets. Nine cusps in this lower and third set occupying same width as the older and higher four. Fig. 8 illustrates this association of cusps. At certain points such as beach salients, no cusps formed, while in the associated beach

curves sheltered by the small cuspate forelands, well marked cusps were formed.

August 4th.—After and during period of westerly winds. Smooth to glassy sea inshore. Strong pulsing movement of water on beach. Low ledge (12 to 18 inches high) formed at low tide mark. Pulses formed here by breaking movement. Undulations thence carried out seaward by interference of backwash and of advancing pulse. No cusps noted on beach at low tide and middle tide marks. High water mark on beach marked by poorly defined cusps becoming less defined each day, while beach profiles becoming gradually more even.

August 10th and 11th.—Very calm weather. Westerly wind. Bank of sand just under water at low water mark with front slightly convex and indented on the seaward aspect, matching the weak cuspate forms of high tide mark on beach. Beach cuspless, except at upper limit of waves. Oily water of bay fell or broke on the edge of this sandbank or ledge (at low water mark) and advanced in pulse fashion up beach. Pulses interfered with each other and at their upward limit on the low tide beach, the wave front presented appearance of countless small sets of interfering wavelets in plan like so many overlapping circular arcs of equal size. These small interfering pulses formed sets which again interfered with each other at spots approximately on same axes as those of the imperfect cuspate forms higher up the beach.

August 12th – 16th.—Fairly strong winds from south-east quadrant. Large cusps produced. Broad hard beach. Two sets of cusps formed later, one seaward of the other. Between these forms cuspate depressions formed which gradually became filled by waves under heavier weather conditions.

September 13th.—Oily water in bay. No waves. Low tide. Sooth, hard, and wide beach devoid of cusps. Low ledge of sand formed under water near low water mark. This in plan formed line parallel to main sweep of beach, that is, it was not indented or cuspate. Pulses from this breaking point sent out broad undulations to bay and advanced up the beach to form numerous evenly-spaced interfering wavelets, which in plan at the wave front gave appearance of overlapping as observed on dates August 10th to 11th (and other dates also). These small forms of cuspate plan formed sets which again interfered at regular intervals.

September 14th and 15th.—Similar features to those observed on September 13th. Westerly (offshore) gale raging.

September 20th.—Heavy gale at sea. Great swell forming lines of breakers for 1,000 yards from shore line. Waves 15 – 20 feet high. Beach formed 175 feet wide. Cusps of widths 54, 64, 54 paces. Later, cusps gone, broad, smooth and elevated beach. Sand cliffs of storm in July indented to form large cuspate forms at base.

September 21st.—Waves decreasing in height. Beach cut down three feet near breaking line. Cusps formed in storm beach (of September 20th). Successive widths of cusps:—

54, 50, 59, 59, 54, 50, 58, 70 paces
70, 64, 64, 60, 54, 50, 49, 51, 49, 50, 53, 57, 54 paces.

Later, scallop heads each divided into two cusps. Cliff of erosion forming. Rollers travelling alongshore from N. to S. at average rate of one mile in from 12 to 15 minutes.

September 22nd.—Waves much reduced in size. Cusp axes shifted slightly. Lower portion of beach seaward of cusps of 21st September now cut up into cusps only possessing an average width of 25 paces. Waves travelling

alongshore from N. to S. at average rate of from 8 to 10 minutes a mile.

Deductions.

The heavy onshore winds of Sydney are from the south-east quadrant. When the heaviest and most continuous winds blow from the south-east, the rain is also generally heaviest and the sea is also piled up in a measure against the land to increase the tidal range. The heavy waves enter Botany Heads and advance across the bay to Lady Robinson's Beach. Although they enter the bay at various angles, nevertheless they break on the beach in such a manner that such breaking wave travels alongshore from N. to S. at a rate of from three to six miles an hour. From a study of the beaches of Sydney it is evident that the main beach outlines have been determined by record storms,[1] while the weather of interstorm periods appears to be capable only of modifying the flood or storm profiles. Thus the north and south points of Lady Robinson's Beach have been determined as to their main features when onshore winds, waves and stream activities have joined their maximum forces. The small foreland at the entrance to Cook's River is a compromise between the flow of the river when in high flood and of the storm waves from the east, coupled with the current generated alongshore by the storm wind and waves. Similarly for the sandy foreland (Doll's Point) forming the southern horn of Lady Robinson's Beach at the entrance to George's River. The two or three small intermediate blunt-nosed forelands at the foot of President Avenue and one mile farther south, for example, arise from the interaction of waves and currents from both ends of the bay. These points have been formed on the seaward aspect of the bay bars which emerged from the waters of the bay possibly not longer since than several hundreds of years.

[1] E. C. Andrews, Geographical Significance of Floods, Proc. Linn. Soc. N.S.W., 1906, p. 828.

The action of storms has also been to pile up another series of great bay bars off-shore of the present Lady Robinson's Beach following upon the emergence of the old bars from the waves.

There still remains the question of origin of the beach cusp or scallop which has received attention from geographers and geologists at various times.

The storm beach associated with shallow offshore areas may be described as a high flat beach of fairly even slope. It is cuspless; it is considerably built up near low water mark as compared with the beach of normal weather, and it is considerably cut down at, and landward of, ordinary high tide mark. The aim of the giant wave is to demolish the solid land, and in endeavouring to carry out its purpose, it builds up a great sand (or pebble) bridge of gentle slope from breaker line to its point of attack so as to minimise its work. The beach in fact is an inclined plane, whose angle of inclination is lowered in proportion to the increase in strength of the wave, and when beach and wave strength are in adjustment the former must be regular and fairly even or smooth because friction has been reduced to a minimum. At the seaward edge of this beach the heavy waves break, and reforming, they advance in continually foaming stage except for the periodic heavy rollers which rush up the beach. Such waves do not appear to have indented fronts, at least not as observed on Lady Robinson's Beach during the storm of July 1912.

Upon the decrease of wave strength such diminished wave finds the storm beach slope ill adjusted to its strength, and straightway it proceeds to adjust the beach profile to its strength. Its wave base[1] is not so far below the sea surface as that of the storm wave. It accordingly breaks

[1] Depth below water surface at which waves can effectively agitate sediments.

closer inshore and excavates the accumulated sand mass in some measure, while the undertow action piles up some of the excavated sand behind it (that is upon the submarine portion of the old storm profile behind the new wave base). Landward of the new wave base it now excavates a narrower and steeper beach out of the storm beach. At its upper limit, however, it proceeds to pile up a small beach crest upon the storm beach. The next point to consider is the manner in which this newer beach profile will be excavated. The breaking wave, now reduced in power, does not pare off slices from the beach after the manner of a sharp knife, because of the nature of water to advance in undulations, such undulations being accentuated in proportion to the lack of adjustment of wave strength and surface passed over. In breaking upon the storm beach the reduced wave is opposed by the returning wave and the resultant of these is broken into pulses which attempt to spread out in circles from the breaking line. Against the on-coming water from the bay such movement is inappreciable, but it is nevertheless appreciable and pronounced in the direction of wave motion up the beach. The size of the undulations moreover is in direct relation to the strength of the breaking wave minus the strength of the backwash. The undulations or pulses thus advance up the beach in the form of modified arcs of circles which mutually interfere, and these imperfect interferences are again arranged in groups until a more perfect interference of waves occurs. At these points the cuspate forms commence to form. The localisation of these cusps is governed in some measure by the salients of the beach, but is effected practically simultaneously along the beach, and the operation once started the interfering waves in their return to the bay form the scallops or cusps. Perhaps in ninety-nine per cent. of the occurrences the undulations which form the cusps by their interference are due to the shape of the front upon which

the waves break, nevertheless, upon the smoothest beach known such undulatory movement of breaking waves must give rise to fairly evenly spaced cusps if only such beach profile be not adjusted to the wave strength, and if there be not present a heavy on-shore wind coming obliquely on to the beach and driving the waves alongshore. Once the operation is started the interfering waves in their return down the beach cut out slight depressions. After a time such action brings about an aggradation of that portion of the shallow water opposite to the intercuspate hollow or furrow, and from this material built up under the water the breaking waves are deflected to right and left, where again, by the onrush of the deeper water opposite the cusp, it is swirled into the furrows and thence in part reflected on to the cusps. At the heads of such interfering pulses in the furrows the water, at a later stage of cusp formation, is again pulsed either straight ahead to spread out like a fan or it is pulsed right and left along the beach both in front of, and across, the advance of the main wave front so as gradually to shift the cusp axes. A common feature associated with decreasing wave-strength at this stage is the partial aggradation of an intercuspate space and the reflection of the undulations on to a cusp so as first to reduce the cusp to a broad triangular facet and secondly to a double cusp.

Cusps will be formed by waves of all descriptions except those which determine the main beach outlines. This reasoning is really only appreciable to the case of waves known as swells. With very heavy crosswinds evenly sloping but cuspless beaches are commonly formed because the regular undulatory nature of the movement is overcome on the beach by the action of the crosswinds (and the currents thus induced), the cross waves from which chase each other irregularly along the beach and obliterate any

regular beach markings. Such beaches have ledges for their upper limits.

Summary.

Lady Robinson's Beach appears to be of recent age (say several hundreds of years) and has been developed upon the seaward aspect of older and elevated bay bars which were formed by storm wave action in an old river valley after the transgression of the sea into the valley during a period of rapid land submergence in late Pleistocene time. During record storm action the interaction of alongshore currents, waves, tides and river flood activities, determined several small salients along the present beach. In periods of heavy storms the beach is wide, smooth, of gentle inclination and raised as to its central portion. With decreasing wave strength the beach is cut into cusps by the interference of undulations produced at the breaking line and such cusps are a temporary phase in the production of one regular beach form out of another.

A study of the beach and the associated beaches and cliffs (as also those of more northern portions of the Eastern Australian Coast) suggests that the present shoreline is in a condition of fairly stable equilibrium, such equilibrium not appearing to have been upset for perhaps several hundreds of years.

A NEW MINERAL.

By A. T. Ullmann,
Chief Assayer, Chillagoe Company, Chillagoe. Queensland.

[*Read before the Royal Society of N. S. Wales, June 5, 1912.*]

The mineral which forms the subject of the present note was found in the Christmas Gift North Mine, Chillagoe, associated with cerussite in a gossan formation, some of the crystals being studded with small crystals of pure cerussite. I have named the new mineral Chillagite.

The crystallisation appears to be tetragonal, the form is tabular and the diaphaneity translucent.

Colour:—Straw or lemon-yellow, sometimes brownish.
Structure:—Lamellar.
Hardness:—3·5. Very brittle.
Specific gravity:—7·5.
Composition[1]:—Tungstate of lead and molybdate of lead, PbO 54·25%, WO_3 28·22%, MoO_3 17·52%.
Formula:—$PbO\ WO_3 + PbO\ MoO_3$.

Before blowpipe—Microcosmic salt bead yielded olive-green in O.F. On charcoal alone, it fused easily, yielding a yellow incrustation of PbO near the assay, and a bluish one on the outer edge of MoO_3.

With Na_2CO_3 on charcoal a prill of metallic lead was produced.

Treatment with HCl and HNO_3 leaves a yellow residue of tungstic acid. A small quantity heated with a drop of H_2SO_4 on a porcelain cover yielded a deep blue colouration due to molybdic acid.

[1] See also report of the Queensland Government Analyst, Queensland Government Mining Journal, XIII, Feb. 1912.—Eds.

On the CRYSTALLINE DEPOSIT OCCURRING in the TIMBER of the "COLONIAL BEECH," *Gmelina Leichhardtii*, F.v.M.

By Henry G. Smith, F.C.S.

With Plates VIII and IX.

[*Read before the Royal Society of N. S. Wales, November 6, 1912.*]

This Australian tree belongs to the Family Verbenaceæ, and is thus not a true "beech." The use of this common name for *Gmelina Leichhardtii* is an unfortunate one, as it really belongs to the genus *Fagus* of the Cupuliferæ. The tree is a native of New South Wales and Queensland, and grows to a considerable size, reaching to a height of 100 to 150 feet, with a diameter of over three feet. It is a useful commercial timber, light in colour, but with little or no figure, and thus cannot be classed as ornamental, although it is useful for carving and similar art purposes.

The seasoned timber often has white particles filling the cells of the wood, and these are sometimes so plentifully distributed that the planed surface has the appearance of having been filled, to a certain extent, with a substance like plaster of Paris. When the timber is not sound this substance often accumulates in "shakes" and cracks of the wood as small opaque deposits and in crystalline masses. The general appearance of the material when thus deposited may be seen from the accompanying photograph, (Plate VIII), which is of natural size. Under the microscope these masses were seen to consist of needle crystals.

The presence of some substance in "beech," different from that of other native timbers, has previously been observed by saw-millers, and in a letter from Mr. W. Smith

of Tinonee, New South Wales, he refers to this peculiarity as follows :—" Port Macquarie Beech contains something of a very cleansing nature. We have a planing machine, and, of course, it gets dirty and stuck all over with sap and dust from tallow-wood and other hardwoods, but as soon as we have put through a few beech boards, where-ever the sappy chippings strike, the ironwork of the machine becomes clean and as bright as new."

Another saw-miller also mentioned that he had seen whitish deposits in "beech" timber, but thought them to be a fungoid growth.

The first well defined deposit of this substance came into the possession of the Technological Museum a few years ago, and as much work as possible was, at that time, carried out with it, a crystalline body being isolated, and its melting point determined. About two years later a small quantity was received from another locality, and similar crystals were again isolated from it and found to be identical in appearance with the first, and to melt at the same temperature. Through the kindly assistance of Mr. Breckenridge, a Sydney timber merchant, a portion of a beech log in a very unsound condition was recently obtained from which a few grams of pure crystals were extracted, sufficient to enable a more extended investigation to be undertaken.

The crystals obtained from all the trees from the various localities were colourless, odourless and tasteless, and were identical in crystalline form, in melting point, in optical activity, and exhibited the same peculiarity in the melting points of the substance when in either the crystalline or the amorphous conditions. From this it is apparent that the deposit is a common constituent in the timber of this species of *Gmelina*, and also that it is a definite chemical substance. It is possible that it may be characteristic of

this tree, or perhaps, peculiar to the genus, and if so, its identification would become of some assistance towards correct diagnosis, especially as no other body appears to be present in the deposit which might contaminate it, and thus interfere with the ready isolation and purification of the crystals.

The peculiarity of this body in what appears to be perhaps an example of dynamic isomorphism in a natural chemical substance, shown by its varying melting points under different conditions, has made its study somewhat interesting, and, so far as the material at disposal would allow, considerable work has been done with it.

The following data will show how great were the differences between the melting points of the crystals and those of the same substance after melting :—

(*a*) When the crystals were prepared by crystallisation from alcohol, or from boiling water, they were quite anhydrous, and melted at 122° C., to a transparent resin-like body, without alteration in weight. This fused material was, at first, strongly electric, and had the power of attracting light particles of filter paper, etc., very energetically. The melting point of this glassy substance had, by fusion, been reduced to 62 – 63° C., and so long as it remained in the glassy condition in the lump, the melting point did not rise, even after many weeks, but if the fused substance was powdered the melting point commenced to rise at once, and after a comparatively short time this had reached about 120 – 121°, but did not appear to revert quite to the melting point of the original crystals.

(*b*) When the fused substance was powdered and the melting point taken at once, this powder melted at the same low temperature as the spangles of solid material, but if the temperature was continually raised, when this had reached to about 100°, the melted substance became

somewhat opaque, but reverted again to the transparent condition at the melting point of the original substance.

(*c*) When the original crystals were boiled in water they softened and apparently fused at that temperature, and, when the solution had become saturated, remained as fused globules or masses in the boiling water, but soon solidified into a semi-crystalline condition when the water had sufficiently cooled, showing that complete fusion had not taken place, because when fused by dry heat the mass always remained as a glass, and there was no sign of crystallisation during the many weeks it remained under observation. If, however, this glass was dissolved in alcohol it again readily crystallised from this solvent, and the crystals were also readily formed from water when the glassy form was boiled directly in the usual way. When thus recrystallised, the melting point of the crystals, both from the alcohol and from the water, had reverted to that of the original crystals, although the melting point of the fused material from which they had been derived had only been 62 – 63°.

(*d*) If the melted glassy substance was broken up into small spangles, but not powdered, these became, after several weeks, opaque and yellowish in colour. The melting point of these opaque spangles had then considerably increased, showing that the tendency is to revert to the higher melting point in all cases, which may thus be considered the stable condition. How many weeks or months it would take for the melted unbroken glassy lump to revert to the higher melting point is not yet known, as sufficient time had not elapsed. So far, this has been found to be 62 – 63°, and in one case three months had passed between the fusion of the substance and the determination of the melting point. The method of observing the melting point of the spangles was to place them on a thin glass microscope

slide cover glass, to float this on mercury, and to observe the melting of the spangles with the aid of a lens. At near the melting point the temperature was only allowed to rise very slowly.

The ready discoloration when bromine water was added to the saturated aqueous solution, with the formation of an insoluble bromide, indicated unsaturation, but this was not confirmed by an alkaline solution of potassium permanganate, as the colour of very dilute solutions remained apparently unchanged for a considerable time, although eventually oxidation to dimethylprotocatechuic acid took place. There appeared to be no alteration on an attempted reduction of the substance, when it was boiled with zinc in an acetic acid solution. The formation of the bromide was also found to have been by substitution, because when bromine was added to a solution of the crystals in carbon tetrachloride, hydrobromic acid was evolved in quantity. Only one atom of bromine was introduced into the molecule by this method, and this was in the side chain, as the bromine was readily removed by boiling alcoholic silver nitrate. The bromide was practically an amorphous body, and attempts to crystallise it were not successful, nor did it show a well defined melting point.

One hydroxyl group was present in the side chain, but no aldehydic group was formed even with mild reagents, the oxidation to a carboxyl group being direct. The action of concentrated halogen acids also indicated the presence of an alcoholic OH group, and bromine was introduced into the molecule when the substance was boiled in hydrobromic acid. The molecule contains two methyoxy groups, and the acid formed by oxidation was veratric acid.

Neither an aldehyde nor carbonyl group was detected, nor were indications for the presence of an ester or of a glucoside obtained.

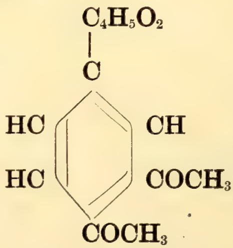
When fused with potash below 200° C., phenolic bodies were principally formed, but when the temperature was increased to about 225° the action became more energetic and the principal product was protocatechuic acid, a very small amount of a volatile acid being produced at the same time. The substance thus has a catechol nucleus.

When more material shall be obtained attempts will be made to determine accurately the arrangement of the atoms in the side chain. The constitution of the remainder of the molecule is shown from the results.

The oxidation to veratric acid, the formation of protocatechuic acid on fusion with potash, the presence of one or more asymmetric carbon atoms, together with the other reactions, suggest a structural formula for this substance in agreement with that of several bodies found in plants, all related to a dihydric phenol, the OH groups of which are in the 3 and 4 positions.

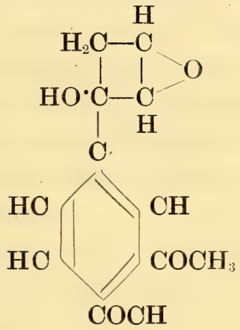
The evidence so far obtained indicates that the crystalline substance which deposits in the timber of *Gmelina Leichhardtii* is new to science, and the name Gmelinol is proposed for it.

The molecule of gmelinol is $C_{12}H_{14}O_4$ and the formula may be arranged as follows:—



The exact positions of the atoms in the side chain have not been accurately determined, as they can be arranged, theoretically, in several ways. The one perhaps the most promising from general reactions, particularly the red

and green colorations given by the vapour to pine wood moistened with hydrochloric acid, is to consider the side chain as consisting of furfurane. This is attached to the nucleus by the β' carbon atom, the double bond broken, the valency completed by one hydrogen attached to one β carbon atom, and a hydroxyl group to the other. The alternative structure for furfurane with only one double linkage answers the requirements better than the usually accepted form. If this arrangement is eventually found to be the correct one, then gmelinol is dimethyoxyphenyl-$\beta\beta'$-hydro-oxyfurfurane, and has the following structure:—



The positions of the nitro groups in the dinitro compound are evident.

The characteristic features of gmelinol may, for convenience, be summarised as follows:—Melting point of crystals 122° C. (cor.); of fused substance 62 – 63°. Needle prisms or plates from hot water. Moderately soluble in boiling water, but little soluble in cold water. Almost insoluble in ether and in benzene. Insoluble in alkalis. Soluble in nitric acid with yellow colour and formation of a dinitro compound. Soluble in concentrated sulphuric acid with a deep red colour. Forms a dark brown amorphous substance when heated with hydrochloric acid. Specific rotation in chloroform $[\alpha]_D = + 123{\cdot}3°$. Chromic acid in acetic acid produces dimethylprotocatechuic acid (veratric acid);

alkaline solution of potassium permanganate also produces veratric acid. Potash fusion at about 225° gives protocatechuic acid.

Experimental.

In one of the pieces of timber from northern New South Wales a small hollow in the wood had become filled with a solid crystalline mass, the greatest thickness of which was about one-eight of an inch, but the usual mode of occurrence appears to be in thin veins more or less distinctly crystallised in rosettes. The substance was scraped off and boiled directly in water, filtered boiling hot, the stem of the funnel being lightly plugged with cotton wool. As the water cooled, well defined crystals formed, which, when of sufficient size, fell to the bottom of the vessel. This procedure was repeated three or four times, by which time the crystals had become colourless, and appeared to be pure. The usual method of preparation was to saw the unsound timber into small pieces, divide along the "shakes," and trim the sides with a chisel. The shavings so obtained were then heated in alcohol to dissolve the substance, filtering the alcohol through cloth. Although it is somewhat soluble in hot alcohol, yet, if this was deficient in amount, a quantity of the substance soon separated on cooling. This separated portion was, however, identical in composition with that remaining in solution, as its identity was determined by separate purification. The alcohol was partly distilled off, and the remainder evaporated down to a small bulk which formed a crystalline mass on cooling. These impure crystals were then dissolved in boiling water, a portion at a time, filtering boiling hot, and this process repeated until the crystals were pure.

The crystals as thus obtained from water were rhombic prisms or plates, and they polarised very well in colours. They were of a glistening nature, and had altogether a

brilliant appearance. The accompanying photograph (Plate IX) gives a good idea of the form of the crystals under the microscope, enlarged 35 times.

The crystals were insoluble in petroleum ether, slightly soluble in ether and in benzene, somewhat soluble in hot alcohol, but not very soluble in cold alcohol. They were exceedingly soluble in chloroform and carbon tetrachloride, but from these solvents a varnish remained at first, which slowly reverted to the crystalline form after several days.

The crystals dissolved in boiling water, but not very readily, separating out again on cooling. The pure crystals required 1470 parts of cold water at 22° C. to dissolve one part of substance, and the purest crude material in the wood was only soluble one part in 1315 parts of cold water at the same temperature, indicating the comparative absence of soluble impurities associated with the crystalline deposit when in the wood.

The aqueous solution of the pure crystals was quite neutral, and did not reduce Fehling's solution, either before or after boiling in acid. An ammoniacal solution of nitrate of silver was slightly reduced on long boiling. No coloration was obtained with ferric chloride, and the usual reagents gave no precipitate, except a very slight one with basic acetate of lead. The crystals were insoluble in potash and in the alkalis generally, even on boiling, except when the solution was sufficiently dilute to act like water, in which case the crystals separated unchanged on cooling.

In glacial acetic acid the crystals dissolved readily and without colour. With nitric acid they dissolved with a yellow colour forming a dinitro compound. With sulphuric acid they dissolved forming a very deep ruby or reddish-brown colour, and on adding water a purple-brown precipitate separated. When heated with hydrochloric acid a dark brown amorphous substance was produced.

Analyses of the crystals gave the following results:—

0·1872 gram gave 0·4444 gram CO_2 and 0·1066 gram H_2O, C = 64·74 and H = 6·327 per cent.

0·1574 gram gave 0·3740 gram CO_2 and 0·093 gram H_2O, C = 64·803 and H = 6·565 per cent.

$C_{12}H_{14}O_4$ contains C = 64·865 and H = 6·307 per cent.

The molecular weight was taken in Beckmann's apparatus using alcohol as the solvent.

0·4775 gram in 16·4 grams alcohol increased the boiling point 0°·16. The molecular weight calculated from this is 209. By the freezing method with acetic acid as solvent, one determination gave 228 as molecular weight, but with other trials abnormal figures were obtained; this was also the case when boiling chloroform was used as solvent.

From the results in other directions it is necessary that four atoms of oxygen at least should be present in the molecule, so that $C_{12}H_{14}O_4$ may be assumed to be correct.

Optical rotation.—The optical rotation was taken in chloroform as this appeared to be the best solvent for the purpose.

0·3 gram crystals in 10 cc. $CHCl_3$ rotated the ray 3·7 degrees to the right in 100 mm. tube; the specific rotation from this $[a]_D = + 123°·33$.

0·6 gram crystals in 10 cc. $CHCl_3$ gave rotation 7·4° to the right in the same tube, showing the specific rotation to be the same for both.

0·3 gram crystals was just melted in a beaker, the glassy substance dissolved in chloroform and made up to 10 cc., the optical rotation was again + 3°·7, so that no alteration was observed between the crystalline and amorphous conditions of the substance.

The molecule thus contains one or more asymmetric carbon atoms, which, from the known constitution of the remainder of the molecule, must be in the side chain.

Dinitro compound.—The crystals were dissolved in nitric acid and gently heated to start the reaction. When this was complete the addition of water gave a lemon-yellow precipitate, which, when purified, was soluble in, and crystallised from, both ether and alcohol. It was readily purified from boiling water in which it readily dissolved, but separated out again in masses of yellow felted crystals on cooling. The melting point was sharp at 128 – 129°, although it agglutinated some degrees below that temperature.

0·1756 of the nitro compound gave 14 cc. of nitrogen at 17° C. and 755 mm. pressure which equals 9·14 per cent. nitrogen. $C_{12}H_{12}(NO_2)_2O_4$ contains 8·98 per cent. nitrogen. It is thus shown to be a dinitro compound.

Methyoxy groups.—The ready formation of insoluble halogen compounds when the crystals were boiled in a halogen acid made the results somewhat erratic. Figures more nearly correct were obtained when acetic anhydride was added, but even then the results were not too satisfactory. The greatest amount of silver iodide obtained in six determinations only represented about one and three-quarter groups of OCH_3, but this, together with the formation of veratric acid on oxidation, is sufficient confirmation for two OCH_3 groups in the molecule.

Hydroxyl group.—A portion of the crystals was boiled with acetic anhydride and sodium acetate in the usual way. On the addition of water a crystalline substance separated, which, when purified from acetic acid melted at 110° C. Analysis gave results in conformity with one OH group. When saponified by boiling with standardised alcoholic potash the following results were obtained :—0·3684 gram boiled two hours had used 0·0756 gram KOH. 0·41 gram boiled one hour had used 0·084 gram KOH. $C_{12}H_{13}(OCCH_3)O_4$ would require 0·0781 gram KOH in the first instance, and

0·087 gram KOH in the second. One hydroxyl group is thus indicated, and as this is not phenolic it must be in the side chain.

Bromide.—The bromide was formed by the addition of bromine water in excess to the saturated aqueous solution of the pure crystals. It was light drab in colour and was not distinctly crystalline. When well washed and purified from either it melted at about 100°, darkening much at about 90°, but the melting point was not sharp.

Determination of the bromine gave the following results: 0·3435 gram gave 0·2114 gram AgBr. = 26·2 per cent. bromine. 0·1554 gram gave 0·0985 AgBr = 26·9 per cent. bromine. $C_{12}H_{13}BrO_4$ contains 26·58 per cent. bromine. One bromine atom had thus been introduced into the molecule. When the bromide was boiled in alcoholic silver nitrate, a precipitate quickly formed; the metallic silver was boiled out from this with dilute nitric acid, the residue washed, dissolved in ammonia and precipitated again by nitric acid. The bromine atom was thus shown to have been introduced into the side chain.

Oxidation.—The crystals were dissolved in glacial acetic acid and chromic acid in the same solvent slowly added until in excess. The oxidation commenced at once with the evolution of heat, the flask was thus cooled under the tap. A chromium salt, which appeared to be insoluble in glacial acetic acid, continued to form until the reaction was complete. This salt was filtered off through cloth, squeezed, and the solid cake thus obtained dissolved in water, in which it was readily soluble. The solution was then acidified, extracted with ether, and after the removal of the acetic acid a solid acid remained. This was dissolved in dilute alkali, filtered, acidified and the solution extracted with ether. The acid thus obtained was fairly soluble in boiling water but precipitated again on cooling, so that it

could be easily purified. The acid sublimed unchanged. The melting point of the sublimed acid was the same as that of the acid obtained from water, this was 180° C. (cor.) It was found to melt at identically the same temperature as a sample of pure veratric acid, nor was the melting point different when equal parts of the new acid and veratric acid were mixed together. The molecular value was determined by titration and agreed very well with that of veratric acid.

When a very dilute alkaline solution of potassium permanganate was added to a large quantity of a saturated aqueous solution of the crystals the colour remained persistent for a long time; it then slowly faded with the formation of the oxide of manganese; oxidation had thus taken place. The acid formed in this way was collected, purified by sublimation, and found to melt at the same temperature and to be identical with the acid formed by oxidation with chromic acid. It was thus veratric acid.

It is apparent that oxidation of the side chain had taken place, in both instances, with the formation of dimethylprotocatechuic acid.

When oxidised with bichromate of potassium and sulphuric acid with the aid of heat, the action was too energetic, and most of the substance was destroyed by this method.

Potash fusion.—When the crystals were heated with potash at a temperature not exceeding 200° C. for one half hour, the colour of the melted substance had become very dark, and phenolic bodies were largely formed. The odour of creosote was most marked. The melt was dissolved in water and the solution repeatedly agitated with ether to remove the unaltered substance. The remainder was acidified, extracted with ether and the ether evaporated. The residue was treated with a solution of sodium carbon-

ate, to fix the small amount of acid formed at the same time, and this solution again extracted with ether. The phenol thus obtained had a marked creosote odour, was but little coloured, was semi-solid and practically insoluble in water. The alcoholic solution was coloured a bluish-green to dark green with ferric chloride, indicating its relation to the catechol group.

A fresh portion of material was fused with potash between 210° and 225° C. for one hour. The action was more energetic at this temperature, with frothing and evolution of hydrogen. The melt was dissolved in water, when the creosote odour was again observed. The solution was acidified and three-fourths distilled over, and although acid, yet, the amount of free acid formed was very small indeed. The remainder was agitated with ether, the ether evaporated to dryness, the crystalline residue dissolved in sodium carbonate and agitated with ether to remove the small amount of phenol. The alkaline solution was acidified, extracted with ether, the ether evaporated, the residue dissolved in water and decolourised by boiling with animal charcoal. The crystals finally obtained were very soluble in water, melted at 198° and gave all the reactions for protocatechuic acid. The yield of acid formed in this way was very good.

I am indebted to my colleague Mr. R. T. Baker, F.L.S., the Curator, for botanical information, and to Mr. Roughley for the photographs.

TWO NEW GRASS SMUTS.

By Ewen MacKinnon, B.Sc.,
Assistant Microbiologist, Government Bureau of Microbiology.

With Plates X–XIII.

[*Read before the Royal Society of N. S. Wales, December 4, 1912.*]

The following smuts are described in the present paper:

1. *Sorosporium panici* on *Panicum flavidum* (Retz.)
2. *Ustilago panici-gracilis* on *Panicum gracile* (R.Br.)

Serial sections have been made through the inflorescences and in connection with the work I have to thank Mr. G. Grant for the photographic work, and Mr. W. A. Birmingham for the drawings of the germinations.

The type specimens will be presented to the National Herbarium at the Botanic Gardens and co-types will be retained at the Government Bureau of Microbiology.

1. *Sorosporium panici*, McK. Panicum.

Sori in the spikelets, confined within the glumes and converting the ovaries into black spore masses, the entire inflorescence being powdered; a central core of plant tissue and an outer membrane enclosing the spore masses. Spore balls rather few except in sections. Variable, common size 50μ, some measuring up to $100 \times 60\mu$. Spores olivaceous or yellowish-brown. Epispore distinctly yet finely echinulate. Variable in size and shape—globose to elliptical often irregular and somewhat angular. Common size $10-12\mu$ diam., but varying 10×12, $10 \times 13{\cdot}6$, $10{\cdot}2 \times 14{\cdot}3$, $8{\cdot}2 \times 14{\cdot}3$, 7×15.

On (?) *Panicum flavidum*, (Retz.), Nyngan Experiment Farm, E. MacKinnon, February 1911.

Spore formation:—The spores originate from a central core of plant tissue and the enveloping membrane corresponds with the flowering glumes (Plate X). The three outer glumes (G. 1, 2, 3) remain quite unattacked. The spore balls are clearly seen in sections of the floret.

Germination:—The spores were germinated in nutrient solutions, as practically no germination took place in water. The type of promycelium depends upon the composition of these solutions. In a solution[1] containing sugar, iron chloride, ammonium nitrate, etc., a promycelium is produced which is at first hyaline and generally conical (Plate XIII, B. 1), becoming granular and warty (B. 4), branching either at the apex (B. 3), or at the base (B. 7). Septa appear, few or many and often close together, with the promycelium constricted and conidia are budded off from the various segments, (B. 5 and 6). In Knop's solution (no iron chloride, or sugar, but containing Ca) the promycelium is generally more slender and grows to a greater length before becoming septate (B. 8, 9, 10). Conidia may be produced (B. 9), or the promycelium breaks up into segments (B. 10). In the latter case the promycelium is more granular and stouter than that producing conidia.

2. *Ustilago panici-gracilis*, McK. Panicum.

Sori involving the whole inflorescence, destroying it, while enclosed in its enveloping leaves, black in the mass and powdery. In some cases the spikelets have expanded, or partly formed before being attacked. Spores dark olivaceous to brownish, varying somewhat in size and shape; mostly subglobose or oval, sometimes oblong or irregular, not so irregular as *Sorosporium panici*. Epispore quite distinctly echinulate. Size common, 11μ diam. or $10 \times 12\mu$, varying from $10 - 15 \times 8 - 12\mu$. A few measured 10×15, and $10 \times 13{\cdot}6$.

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[1] Duggar, Fungus Diseases, p. 26.

On *Panicum gracile*, R.Br., Nyngan Experiment Farm, E. MacKinnon, February 1911.

Morphology:—The inflorescence when badly attacked is completely altered (Plate XII), forming a contracted and irregularly swollen boil-like growth. Serial sections show a central mass of plant tissue with numerous vascular bundles. Cavities filled with spores (Plate XI) occur in this core, and the whole is surrounded by a thin enveloping membrane which appears to originate from the leaf sheath, and which ruptures irregularly to allow the escape of the black powdery spores. No trace of definite spore balls is evident throughout the whole series of sections. That this is a different smut to *Sorosporium panici* is shown by the absence of spore balls by the slightly darker and more distinctly echinulate spores, the variations in germination and its marked difference on the inflorescence.

Germination:—Spores placed in water commenced to germinate in forty-eight hours sending forth a hyaline promycelium (Plate XIII, C. 1) or in many cases two promycelia (C. 5), one usually larger than the other and developed from opposite sides of the spores, or the promycelium may divide at the base. For the development of conidia a nutritive solution[1] gave the best results; Knop's solution was not so satisfactory, and no conidia were formed in water. The promycelium may be quite long or relatively short when septa first form (C. 2 and 3). The septa may appear near the spore or near the distal end. Branches soon form, often at right angles (C. 4). Conidia are produced laterally or terminally—very frequently by a condensation of the protoplasm into masses which leave the promycelium as a hyaline empty sheath. Where two promycelia come into contact a fusion may take place, often producing a knotty, irregular mass, and similarly when a

[1] Duggar, Fungus Diseases, p. 26.

promycelium comes in contact with another spore it may form a nodular growth round it (C. 7), and there appears to be a fusion of the protoplasm. The growing mycelium stains readily with carbol-fuchsin, and (C. 6) shows the central mass of protoplasm in the spore extending into the hyaline projection, and as a central core with a clear enveloping sheath in the longer promycelium.

Explanation of Plates.

Plate X.—Cross section of floret of *Panicum flavidum*, showing central core of tissue, spore balls of *Sorosporium panici* and glumes G. 1, G. 2, G. 3.

Plate XI.—Cross section of spikelet of *Panicum gracile* (distorted head) showing core of tissue with cavities filled with spores of *Ustilago panici-gracilis*, and thin enveloping membrane.

Plate XII.—Photograph of *Panicum gracile* affected with *Ustilago panici-gracilis*, showing normal inflorescence and distorted inflorescences.

Plate XIII.—Germination of Spores. B (1 – 7) *Sorosporium panici* in nutrient solution (Duggar); (8 – 10) in Knop's solution. C (1 – 7) *Ustilago panici-gracilis.*

NOTE ON THE OCCURRENCE OF THE GENUS *SPIRANGIUM* IN THE HAWKESBURY SERIES OF NEW SOUTH WALES.

By W. S. DUN.

With Plate XIV.

[*Read before the Royal Society of N. S. Wales, December 4, 1912.*]

THROUGH the kindness of Mr. W. Gelme, I have had the opportunity of examining four imperfect specimens of *Spirangium* from the brickpits at Brookvale, near Manly.

The specimens occur as impressions in a blue-gray shale associated with *Phyllotheca*, *Alethopteris sp.*, *Thinnfeldia*, and fish—*Cleithrolepis*, *Semionotus*, *Dictyopyge*, and *Pristisomus ?*

The most perfect specimen, that figured on Plate XIV, has a length, as preserved, of 19 cm., but the stalk-like appendages are imperfect—the inflated vesicle (?) is 10 cm. long, and the spindle-shaped body is traversed by two opposed series of helicidal ridges, each nine in number, dividing the surface into compartments 7 by 10 mm., broader than long on the main mass, though at the extremities the tetragonal compartments are naturally more elongated.

These peculiar fossils have been found at various horizons from Carboniferous to Lower Mesozoic in Europe and America, and have been described under several generic names—Palæozyris, Palæobromelia, Fayolia—a much larger form from the Permian of France which may have a similar origin.

The forms are generally classed now under the name of *Spirangium* and though various interpretations have been

made,—such as fructification of primitive zyrids (?), or portion of one of the Characeæ, vesicles for flotation,—the observations of recent years point to the possibility of their being of animal origin, either the egg case of one of the primitive Selachians or a coprolite, such as *Spiralium* of the Devonian of America.

It is not proposed to discuss the affinities at the present time, but it is hoped that it will be possible soon to determine the exact horizon of the shale bed from which the fossils were derived, and also to obtain further material which will then form the subject of a more detailed account.

So far as at present known the shale bed forms either the basal portion of the Wianamatta Stage or an intercalated bed in the Upper Hawkesbury Sandstone Stage.

SOME CRYSTAL MEASUREMENTS OF CHILLAGITE.

By Miss C. D. Smith, B.Sc., and Leo A. Cotton, B.A., B.Sc.,
Department of Geology, University of Sydney.
[With Plates XV, XVI.]

[*Read before the Royal Society of N. S. Wales, December 4, 1912.*]

The crystals measured and discussed in this paper were kindly supplied to us by Mr. A. J. Ullmann of Chillagoe. In December of last year Mr. Ullmann wrote to Professor David, reporting to him the discovery of what he thought was a new mineral, and forwarding a sample of the same. The new substance was stated by Mr. Ullmann to contain lead, molybdenum and tungsten. It is thus related to both stolzite and wulfenite. As no such mineral combination had hitherto been recorded, the name Chillagite was suggested by Professor David.

The Queensland Department of Mines also obtained samples of the material from the same mine, and an analysis was prepared which was published in February of of the present year. This analysis corresponds closely to the formula $PbO\ MoO_3\ PbO\ WO_3$. Shortly after this Mr. Ullmann submitted a note to this Society giving an account of the occurrence of the mineral and also the results of a qualitative analysis. He also stated that the composition was $PbO\ MoO_3\ PbO\ WO_3$ and gave the theoretical proportions of PbO, MoO_3 and WO_3 for this formula.

In June last, the Queensland Department of Mines forwarded Professor David a copy of a report embodying still later analyses. That portion of the report giving the analyses reads as follows:—

"The report on the previous sample was made on a limited supply of crystals, but the present sample was sufficiently large to allow a more general examination to be made. The present sample differed from the previous one in containing a considerable

proportion of flat orange-yellow transparent crystalline plates, some of these, while quite transparent in the centre, were lemon coloured and translucent on the edges.

"The greater part of the sample was made up of flat crystalline plates, the colour varying from orange-yellow to lemon-yellow, the lemon-yellow parts being only translucent, but the orange coloured parts more or less transparent. Some crystals were dark and opaque in parts, and this was found to be due to an inclusion of carbonate of lead.

"There were just a few other crystals of even lemon yellow colour and of different crystalline habit, the specimens showing an uneven crystalline surface, quite distinct from the flat smooth crystals mentioned above. It was these crystals which were found in the previous sample.

"Two lots of crystals were selected for analysis, the first lot being more or less orange coloured, and the second lot all lemon coloured crystals. The analysis gave 16·8 per cent. and 22·7 per cent, of tungstic acid respectively, the lot with the more lemon colour thus showed the more tungstic acid.

"An analysis was then made on a carefully selected lot of the clear transparent orange coloured flat plates. These had a hardness 3 to $3\frac{1}{2}$, and specific gravity 7·05. The analysis showed

Tungstic acid (WO_3)	trace
Molybdic acid (MoO_3) ...	39·5 %
Lead oxide (PbO)	59·8 %

proving these crystals to be molybdate of lead. The analysis corresponds approximately to the formula $PbMoO_4$.

"Two lots of the lemon coloured crystals with uneven crystalline surface were then picked. These had a hardness 3 to $3\frac{1}{2}$ and specific gravity 7·30. The analysis showed

	(*a*)	(*b*)
Tungstic acid (WO_3) ...	23·5 %	21·1 %
Molybdic acid (MoO_3) ...	(lost)	22·0
Lead oxide (PbO)	54·0	54·5

"This analysis (*b*) corresponds approximately to the formula 3 $PbWO_4$, 5 $PbMoO_4$."

From this report it appears that three types of crystals were present.

(1) Transparent orange coloured plates.

(2) Partly transparent orange coloured and partly translucent lemon yellow plates.

(3) Translucent lemon yellow plates.

The first were shown to be definitely wulfenite. In the third the percentage of tungstic acid is fairly constant, varying from 21.1 to 23.5 per cent. The lead oxide was also constant where determined. The second group of crystals were intermediate in both physical properties and chemical composition to the first and third groups.

The crystals supplied to us by Mr. Ullmann possessed the physical characters of the third type being translucent lemon yellow crystals.

They were set in a gossan matrix commonly having two edges embedded and the other two free. Where the crystals were grouped, they either formed an irregular cell structure or were arranged with an approximate parallelism of the basal planes. In two of the crystals measured three edges were present, but in the remaining five only two edges could be obtained. As the crystals actually measured were small, varying from 1.5 to 3 mm. in diameter, they could not be analysed.

They were flat thin square crystals, the edges being up to 1 cm. in length and about 2 mm. in thickness. The basal planes were large and the pyramid faces of the first order well developed. These appeared to make but relatively small angles (less than 30°) with basal planes. The crystals were extremely brittle and fragile, and only fragments could be obtained for measurement.

The following tables give the measurements recorded for the crystals. These were read on a two circle goniometer. The explanation of the tables is as follows:—

The letters indicate the names proposed for the forms. These are the same as the letters given to similar faces on stolzite and wulfenite where these corresponding forms are known.

The indices are given in Miller's notation. The measured angles for ϕ have been placed in two columns which are so arranged that the first order pyramids in either column are in the same zone. The signs + and − prefixed to the ϕ reading indicate faces developed on the same and opposite sides of the crystal respectively, as the standard basal plane. Faces underlined in the Tables VI and VII indicate faces in the same zone as but along the opposite edge to the other faces in the same column.

Faces marked with an asterisk are referred to the forms represented by the letters by which they are distinguished, but were not considered to be sufficiently well developed to be included in deducing the mean values represented in Table VIII. The columns marked $E\phi$ and $E\rho$ show the difference in minutes from the mean values of the goniometer measurements. These have been incorporated as a measure of the degree of perfection of the crystal faces. The columns $\delta\phi$ and $\delta\rho$ express the differences of the measured ϕ and ρ from the theoretical value calculated from the corresponding indices.

On all the crystals measured two basal planes were present, one of which showed a relatively good signal and the other a very poor one.

The latter was in some cases only represented by an indistinct blur of light. The basal plane with the better signal was in each case selected as the standard of reference for the other faces.

Crystal No. 1.—The forms developed are *c*, *f* and *e*. Of these the dominant ones are *c* and *f*. The faces approximating to the form *y* were too small to be seen, but their reflections show that they were symmetrically developed.

TABLE I.

Face.	Miller Indices.	Measured ϕ.	Eϕ.	Measured ρ.	Eρ.	Calculated ϕ	Calculated ρ.	$\rho\phi$	$\delta\rho$.
		° ′ ° ′	′	° ′	′		°	° ′	′
c	001	–	1	0	2	–	0	–	0
c′	001	–	2	17	2	–	0	–	17
e	011	+5	½	57 16	½	0	56 49	5	27
y	119	-45 38	3	13 49	1	45°	13 30	38	19
*y	,,	-47 5	3	14 11	4	,,	,,	2 5	41
*y	,,	+46 13	3	14 21	4	,,	,,	1	51
*y	,,	-43 10	1	14 7	4	,,	,,	1 50	37
f	115	+44 58	–	23 17	½	,,	23 23	2	5
f	,,	-45 2	½	23 20	–	,,	,,	2	3
f	,,	+45 9	½	23 23	½	,,	,,	9	0
f	,,	-44 49	½	23 23	½	,,	,,	11	0

Crystal No. 2.—The chief forms developed are c, θ, x and f. Of these c and f are the dominant ones, the latter being symmetrically developed. In the case of the forms θ and x only one face of each was found. The form y is represented by three faces, but only one of these is reasonably well developed. The faces represented by the forms θ, X and x were not observed on any other crystal measured. The chief forms are represented in figs. 1 and 2, Plate XVI.

TABLE II.

Face.	Miller Indices.	Measured ϕ.	Eϕ.	Measured ρ.	Eρ.	Calculated ϕ	Calculated ρ.	$\delta\phi$.	$\delta\rho$.
		° ′ ° ′	′	° ′	′		° ′	° ′	° ′
c	001	–	½	0	½	–	0	–	0
c′	001	–	4	4	1	–	0	–	4
θ	0 32	44	1	65 3	5	0	66 27	44	21
X	0 94	10	1	73 46	2	,,	73 48	10	2
*y	1 19	+43 8	1	12 53	½	45°	13 30	1 52	37
y	,,	-44 38	–	13 26	–	,,	,,	22	4
*y	,,	+46 35	–	14 38	–	,,	,,	1 35	1 8
*g	1 16	+43 12	4	20 38	8	,,	19 49	1 48	49
*g	,,	-43 7	–	21 26	–	,,	,,	1 53	1 37
f	1 15	-44 30	-	23 16	–	,,	23 23	30	7
,,	,,	+45 13	½	23 34	2	,,	,,	13	11
,,	,,	+45 17	–	23 42	1	,,	,,	17	19
f	1 15	-45 51	–	23 45	–	,,	,,	51	22
*d	1 14	-41 48	–	28 8	–	,,	28 23	3 12	22
* ,,	,,	+45 20	½	28 45	2	,,	,,	20	1 3
*p	1 11	-46	1	57 19	½	,,	56 49	1	30
,,	,,	+45 50	½	57 32	3	,,	,,	50	43
*x	3 43	+36 2	–	67 19	2	36°52′	68 22	50	1 3
* ,,	,,	+36 1	⅓	72 43	2	,,	,,	51	4 21

Crystal No. 3.—Few faces were present on this crystal. Only one representative face of each of the forms *c*, *k*, *G*, *F* and *f* was observed.

TABLE III.

Face.	Miller Indices.	Measured φ.		E φ	Measured ρ.	E ρ.	Calculated. φ	Calculated ρ.	δφ.	δρ.
		° ′	° ′	′	° ′	′		° ′	° ′	′
c	001	–		3	0	1	–	0	–	0
c′	001	–		½	14	1	–	0	–	14
k	1 17	+44 40		–	16 42	–	45°	17 10	20	28
*,,	1 17	-43 27		–	18 1	-	,,	,,	1 33	51
*g	1 16	-43 47		–	18 58	–	,,	19 49	1 13	51
,,	1 16	+44 4		–	18 59	–	,,	,,	56	50
G	2 2 11	-44 43		–	21 26	–	,,	21 28	17	2
F	3 3 16		-44 39	–	22 15	–	,,	22 5	21	10
f	1 15		+44 40	1	23 47	½	,,	23 23	20	24
*w	22 5	-43 45		1	40 52	1	,,	40 51	1 15	1

Crystal No. 4.—This was the only crystal measured on which the form *f* was not present. The dominant faces are *c* and *l*.

TABLE IV.

Face.	Miller Indices.	Measured φ.		E φ.	Measured ρ.	E ρ.	Calculated φ	Calculated ρ.	δφ.	δρ.
		° ′	° ′	′	° ′	′		° ′	° ′	° ′
c	001	–		½	0	½	–	0	–	0
c′	001	–		½	11	–	–	0	–	11
* τ	013	1 4		–	28 17	½	0	27 1	1 4	1 16
S	1 1 10		+45 50	–	11 43	–	45°	12 12	50	29
l	118	-44 28		–	14 25	–	,,	15 7	32	42
l	,,		-44 56	–	14 54	1	,,	,,	4	13
l	,,		-44 56	–	15 39	1	,,	,,	4	32
l	,,		-44 56	–	16 2	1	,,	,,	4	55
d	114	-44 1		–	28 30	-	,,	28 23	59	7
,,	,,		+45	½	28 41	–	,,	,,	0	18
D	6 6 23		-45 18	–	29 10	½	,,	29 26	18	16

Crystal No. 5.—The chief forms are *c*, *f* and *l*. The two former are developed symmetrically and determine the shape of the crystal. Ditetragonal pyramids are represented by *z* and π.

TABLE V.

Face.	Miller Indices.	Measured ϕ.		E ϕ.	Measured ρ.	E ρ.	Calculated ϕ	Calculated ρ.	$\delta\phi$.	$\delta\rho$.
		° ′	° ′	′	° ′	′		° ′	′	° ′
c	001	...		1	0	½	–	0	–	6
c′	001	...		5	6	½	–	0	–	0
y	1 19		– 45	4	13 1	½	45°	13 30	0	29
,,	,,		– 45	2	13 58	½	,,	,,	0	28
Z	2 2 17	+44 56		½	14 26	1	,,	14 16	4	10
l	1 18		+45 4	3	14 50	1	,,	15 7	4	17
l	,,		– 45	½	14 51	½	,,	,,	0	16
l	,,	+45		½	15 39	–	,,	,,	0	32
l	,,		+45 4	–	15 43	1	,,	,,	4	36
g	1 16		– 44 21	1	19 32	½	,,	19 49	39	17
*f	1 15	– 45 52		½	22 11	1	,,	23 23	52	1 12
f	1 15	+44 45		1	23 7	21	,,	,,	15	16
f	,,		– 45	½	23 13	–	,,	,,	0	10
f	,,	+45 15		½	23 23	2	,,	,,	15	0
f	,,		+44 56	21	,,	1	,,	,,	4	0
f	,,	– 45 20		1	24 20	5	,,	,,	20	57
D	6 6 23	– 45 4		1	29 8	3	,,	29 26	4	18
D	,,	+44 46		2	29 28	½	,,	,,	14	2
b	1 13	+45 9		½	36 5	1	,,	35 47	9	18
b	,,	– 44 53		½	36 12	5	,,	,,	7	25
*z	2 77	– 16 17		0	56 26	½	15 57	57 50	20	1 24
π	1 33	+18 57		20	57 42	½	18 26	58 11	31	29

Crystal No. 6.—Three sides of this crystal were available for measurement. The dominant forms are *c*, *f* and *l*. The second order pyramids are represented by *e* which is not however well developed. The forms *d* and *p* are also worthy of mention as they represent faces with simple indices.

TABLE VI.

Face.	Miller Indices.	Measured ϕ.		E ϕ	Measured ρ.	E ρ.	Calculated ϕ.	Calculated ρ.	$\delta\phi$.	$\delta\rho$.
		° '	° '	'	° '	'		° '	° '	° '
c	001	–		½	0	–	–	0	–	0
c'	001	–		10	21	3	–	0	–	21
*e	0 11		2 36	–	58 42	–	45°	56 49	2 36	1 53
*Y	1 1 18	+47 57		2	6 47	½	,,	6 51	2 57	4
*Y	,,		+42 43	2	7 7	½	,,	,,	2 17	16
*y	1 19	+43 37		½	11 46	½	,,	13 30	1 23	1 44
*,,	,,		+47 9	1	12 12	½	,,	,,	2 9	1 18
*,,	,,		+46 50	–	13 5	½	,,	,,	1 50	25
,,	,,	−44 30		2	13 30	33	,,	,,	30	0
*l	1 18	+46 36		4	14 24	5	,,	15 7	1 36	43
*,,	,,		+46 37	5	14 51	½	,,	,,	1 37	16
*,,	,,		+40 15	½	15 30	2	,,	,,	4 45	23
,,	,,	−44 27		2	15 40	7	,,	,,	33	33
,,	,,		−45 57	3	16 15	–	,,	,,	57	1 8
*,,	,,		+46 18	½	16 22	½	,,	,,	1 18	1 15
*k	1 17		−43 45	2	18 27	3	,,	17 10	1 15	1 17
*g	1 16		−43 51	1	20 6	4	,,	19 49	1 9	17
G	2 2 11	+45 2		1	21 5	7	,,	21 28	2	23
F	3 3 16	−45 10		1	22 5	2	,,	22 5	10	0
,,	,,		−44 50	1	22 29	5	,,	,,	10	24
,,	,,		+45 5	½	22 37	3	,,	,,	5	32
f	1 15	+45		1	23 13	3	,,	23 23	0	10
f	,,		−45 52	2	23 35	1	,,	,,	52	12
*f	1 15		−45 53	–	24 30	–	,,	,,	53	1 7
*d	1 14		+46 6	20	27 44	10	,,	28 23	1 6	39
,,	,,		−45 2	13	27 56	4	,,	,,	2	27
*,,	,,		+43 47	19	29 21	7	,,	,,	1 13	58
*,,	,,	−40 10		1	30 44	½	,,	,,	4 50	2 21
p	1 11		+44 49	½	64 40	–	,,	65 11	11	31
*,,	,,		+45 33	2	66 46	–	,,	,,	53	1 35

Crystal No. 7.—This crystal also possessed three sides which could be measured. The forms c, *f* and *d* are prominently developed. All the other forms present possess at least one good representative face.

TABLE VII.

ace.	Miller Indices.	Measured ϕ.		$E\phi$.	Measured ρ.	$E\rho$.	Calculated ϕ.	Calculated ρ.	$\delta\phi$.	$\delta\rho$.
		° ′	° ′	′	° ′	′		° ′	° ′	′
c	001	—		1	0	3	—	0	—	0
c′	001	—		3	4	½	—	0	—	4
S	1 1 10	+44 55		—	12 36	—	45°	12 12	5	24
*l	1 18		+43 39	—	15 10	—	,,	15 7	1 21	3
l	,,	+45 42		—	15 31	—	,,	15 7	42	24
k	1 17		−44 57	—	17 16	½	,,	17 10	3	6
g	1 16		−44 51	—	19 21	2	,,	19 49	9	28
G	2 2 11		+45	½	21 26	½	,,	21 28	0	2
F	3 3 16		−45	2	22 4	2	,,	22 5	0	1
f	1 15	−44 35		—	23 25	—	,,	23 23	25	2
f	,,		+45 10	1	23 29	—	,,	,,	10	6
f	,,	−44 28		—	23 57	—	,,	,,	32	34
d	1 14	−44 29		—	27 56	—	,,	28 23	31	33
d	,,	+44 35		—	28 12	—	,,	,,	25	11
d	,,		+45 14	2	28 32	—	,,	,,	14	9
d	,,		+44 54	15	28 44	—	,,	,,	6	21

The following table gives the mean values of ϕ and ρ and their differences from the calculated values. It also shows the number of faces considered in deducing these mean values and the variations in their measurements.

TABLE VIII.

Form.	Miller Indices.	No. of Faces.	Range of ϕ.	Range of ρ.	Mean ϕ	Mean ρ.	Calculated ϕ.	Calculated ρ	$\delta\phi$.	$\delta\rho$.
			° ′ ° ′	° ′ ° ′	° ′	° ′	° ′	° ′	° ′	° ′
τ	013	1	...	...	1 4	28 17	0	27 1	1 4	1 16
e	011	1	...	...	5	57 16	0	56 49	5	27
θ	032	1	...	...	44	65 3	0	66 27	44	1 24
X	094	1	...	...	10	73 46	0	73 48	10	2
Y	11 18	1	...	...	47 57	6 47	45	6 51	2 57	4
S	11 10	2	44 55 – 45 50	12 36 – 12 41	45 5	12 38	45	12 12	5	26
y	119	6	44 30 – 46 0	13 21 – 13 51	44 58	13 43	45	13 30	2	13
Z	22 17	1	...	...	44 56	14 26	45	14 16	4	10
l	118	10	44 27 – 45 42	14 25 – 16 2	44 57	15 13	45	15 7	3	6
k	11 7	2	44 40 – 44 57	16 42 – 17 16	44 50	17 2		17 10	10	8
g	116	3	44 4 – 44 51	18 59 – 19 32	44 40	19 31	45	19 49	20	18
G	22 11	3	44 43 – 45 2	21 5 – 21 26	44 56	21 21	45	21 28	4	7
F	33 16	5	44 39 – 45 10	22 4 – 22 37	44 58	22 18	45	22 5	2	13
f	115	19	44 28 – 45 51	23 7 – 24 20	45	23 26	45	23 23	0	3
d	114	7	44 1 – 45 14	28 12 – 28 56	45 6	28 35	45	28 23	6	12
D	66 23	3	44 46 – 45 18	29 8 – 29 28	45 2	29 17	45	29 26	2	9
b	113	2	44 53 – 45 9	36 5 – 36 12	45 1	36 8	45	35 47	1	21
w	225	1	...	...	43 45	40 52	45	40 51	1 15	1
p	111	3	44 49 – 45 60	64 40 – 65 54	44 58	65 20	45	65 11	2	9
z	277	1	...	...	16 17	56 26	15 57	57 50	20	1 24
π	133	1	...	...	18 57	57 42	18 26	58 11	31	29
x	343	1	...	...	36 2	67 19	36 52	68 22	50	1 3

The stereographic projection (Plate XV) exhibits most of the forms in the above table. Some have been omitted to avoid confusion.

The combinations of the forms present on each crystal are shown in the table below. The asterisk has the same significance as in the previous tables:—

Crystal	c	τ	e	θ	X	Y	S	y	Z	l	k	g	G	F	f	d	D	b	w	z	π	p	x
No. 1	c	–	e	–	–	–	–	y	–	–	–	–	–	–	f	–	–	–	–	–	–	–	–
,, 2	c	–	–	θ*	X	–	–	y	–		–	g*	–	–	f	d*	–	–	–	–	–	p*	x*
,, 3	c	–	–	–	–	–	–	–	–	–	k	g*	G	F	f	–	–	–	w*	–	–	–	–
,, 4	c	τ*	–	–	–	–	S*	–	–	l	–	–	–	–	–	d	D	–	–	–	–	–	–
,, 5	c	–	–	–	–	–	–	y	Z	l	–	g	–	–	f	–	D	b	–	z*	π	–	–
,, 6	c	–	c*	–	–	Y*	–	y	–	l	k*	g*	G	F	f	d	–	–	–	–	–	p	–
,, 7	c	–	–	–	–	–	S	–	–	l*	k	g	G	F	f	d	–	–	–	–	–	–	–

The most prominent faces developed as shown by the above tables are:—c, *y*, *l*, *k*, *g*, *G*, *F*, *f* and *d*, of these the faces c, *y*, *l* and *p* are the most common.

Form C.—In all the crystals two basal planes were present, one of which showed a fairly good signal and the other a poor one. The angles between the basal planes as recorded vary from 4′ to 21′.

Forms y and l.—These are closely related as they represent the 119 and 118 faces respectively. The former has been found prominently developed on stolzite.[1]

Form f.—The faces belonging to the form *f* (115) are developed on all the crystals measured, with the exception of crystal 4. This crystal appeared on inspection to be similar to the others measured. Very possibly this is due to the form *d* (114) being more prominently developed than in the case of the other crystals. The readings for the faces of the form *f* were so constant that this face was taken as the standard. Eighteen faces of this form were developed. The ρ's of four of them were exactly 23° 23′; the mean reading of the 19 faces developed gave the value as 23° 26′.

Knowing that the crystals measured were related to wulfenite and stolzite, the measurement of these minerals as recorded in Goldschmidt were referred to, in order to connect them with the crystal measurements if possible. The standard value 23° 23′ was nearest the value 26° 22′ which was the ρ for the 229 faces on wulfenite. Assuming the indices of the standard face to be 115, the ρ for the 011 face was brought into the closest agreement with that for the 011 face of both wulfenite and stolzite.

By means of this standard face the value of the "c" axis was determined as :— 1. 5291

That of wulfenite is 1. 5774 }[2]
That of stolzite is 1. 5606 }

[1] E. Artini, Uber den Stolzit von Bena, Padru (Ozieri) Zeit. f. Kryst. Vol. XLIII., pp. 422-3, 1907.

[2] Goldschmidt, Krystallographische Winkeltabellen.

The examination of the crystals from the measurements in the tables show that they belong to the tetragonal system. The scanty development of ditetragonal pyramids and the entire absence of any prism faces renders it somewhat doubtful as to which group the crystal belongs. The marked difference in the degree of development of the basal planes suggests that the crystals may be hemimorphic. This unequal development of the basal planes has been recorded both for wulfenite[1] and stolzite.[2] Provisionally, therefore, the crystals have been classed in the pyramidal hemimorphic group.

The following table shows the faces common to the crystals measured, wulfenite and stolzite respectively:—

	1. Chillagite.	2. Wulfenite.	3. Stolzite.
013	τ	τ	τ
011	e	e	e
032	θ	θ	–
*113	b	b	b
111	p	p	p
133	π	π	π
*115	f	–	f
*117	k	–	k
*119	y	–	y

The forms marked with an asterisk have been recently recorded as new for stolzite.[3] It thus appears that though in their occurrence the crystals are associated with wulfenite, their crystal measurements are more nearly related to stolzite.

The value of *c* axis is not intermediate to that of stolzite or wulfenite, but is less than that of either of these minerals.

[1] Charles A. Ingersoll, On Hemimorphic Wulfenite Crystals from New Mexico. Am. Jour. Science, 1894.

[2] Dr. C. Hlawatsch, On Stolzite and a new Mineral Raspite from Broken Hill. Rec. Geol. Surv. N.S.W., 1898, Vol. VI, Part 1, pp. 51 – 61.

[3] E. Artini, *loc. cit.*

It is possible that a small percentage of scheelite or fergusonite molecules may be present, and this might account for the low value of c.[4] Moreover the value c for chillagite differs considerably from the range of values recorded for stolzite or wulfenite. The values of c recorded for stolzite are :—

(1)	1.5576 [1]	(6)	1.5613 [2]
(2)	1.5579 [2]	(7)	1.5631 [2]
(3)	1.5586 [2]	(8)	1.5667 [4]
(4)	1.5597 [2]	(9)	1.5692 [5]
(5)	1.5606 [3]		

For wulfenite the only values of c found were :—

1.7771 [4] 1.7774 [6]

There thus appears to be some evidence in favour of the crystals representing a new mineral, but more is needed before this can be definitely established.

Our thanks are due to Dr. C. Anderson of the Australian Museum for advice in connection with part of the work.

Explanation of Plates.

Plate XV is the Stereographic Projection of most of the forms found. A number of important forms have been omitted to avoid confusion in the figure. The forms represented by open circles are not so well developed as those represented by the black dots.

Plate XVI, fig. 1 is an Orthographic Projection of Crystal 2.

Fig. 2 is the corresponding Clinographic Projection of Crystal 2.

[1] Zeit. f. Kryst. Vol. XLIII, 1907. [2] Hlawatsch, *loc. cit.* [3] Hlawatsch, Uber Stolzit and Raspit von Brokenhill, Zeit f. Kryst. Vol. XXIX. [4] Zeit. f. Kryst. Vol, XLV, 1908, p. 93. [5] A. Levy, On a tungstate of lead, Ann. of Phill,, Neue Serie, XII, p. 364. [6] Goldschmidt, *loc. cit.*

ABSTRACT OF PROCEEDINGS

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of New South Wales.

ABSTRACT OF PROCEEDINGS, MAY 1st, 1912.

The Annual Meeting, being the three hundred and forty-eight (348th) General Meeting of the Society, was held at the Society's House, No. 5 Elizabeth-street North, at 8 p.m.

Mr. J. H. MAIDEN, President, in the Chair.

Fifty-one members and nine visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of candidates for admission as ordinary members were read; one for the second, and one for the first time.

Dr. C. ANDERSON and Mr. C. A. SUSSMILCH were appointed Scrutineers, and Dr. J. B. CLELAND deputed to preside at the Ballot Box.

The following gentleman was duly elected an ordinary member of the Society:—

Dr. FREDERICK PARNELL PAUL, Point Piper, Sydney.

It was announced that the Council had awarded the Clarke Memorial Medal to Mr. W. H. TWELVETREES, Government Geologist of Tasmania, and a letter from that gentleman, expressing his appreciation of the honour, was read.

Dr. C. J. MARTIN, F.R.S., Director of the Lister Institute of Preventive Medicine, was nominated by the Council as an Honorary Member of the Society, and on the nomination being put to the meeting, he was elected wlth acclamation.

It was announced that Professor DAVID had been elected Chairman, and Mr. C. A. SUSSMILCH, Secretary, of the Geological Section for the forthcoming Session.

The President then delivered the Annual Address.

Professor DAVID moved and Mr. R. T. BAKER seconded a proposal that the thanks of the Society be accorded to the President for his address, and also for his services during the past year.

There being no other nominations, the President declared the following gentlemen to be Officers and Council for the coming year :—

President :

R. H. CAMBAGE, L.S., F.L.S.

Vice-Presidents :

H. D. WALSH, B.A.I., M. INST. C.E.	Prof. T. W. E. DAVID, C.M.G., B.A., D.SC., F.R.S.
F. H. QUAIFE, M.A., M.D.	F. B. GUTHRIE, F.I.C., F.C.S.

Hon. Treasurer :

D. CARMENT, F.I.A., F.F.A. (Dr. H. G. CHAPMAN, *Acting*.)

Hon. Secretaries :

J. H. MAIDEN, F.L.S.	Prof. POLLOCK, D.SC.

Members of Council :

H. G. CHAPMAN, M.D.	CHARLES HEDLEY, F.L.S.
J. B. CLELAND, M.D., CH.M.	T. H. HOUGHTON, M. INST. C.E.
W. S. DUN.	F. LEVERRIER, B.A., B.SC., K.C.
R. GREIG-SMITH, D.SC.	HENRY G. SMITH, F.C.S.
W. M. HAMLET, F.I.C., F.C.S.	W. G. WOOLNOUGH, D.SC., F.G.S.

Mr. MAIDEN, the outgoing President, then installed Mr. CAMBAGE as President for the ensuing year, and the latter returned thanks to the members.

As the Report of the Council and the Financial Statement had not been presented, it was resolved, on the motion of Mr. MAIDEN, seconded by Professor DAVID, that this

meeting stand adjourned until Wednesday 5th, June, 1912, such adjourned meeting to precede the usual General Monthly Meeting of members.

ABSTRACT OF PROCEEDINGS, JUNE 5th, 1912.

The three hundred and forty-eighth (348th) General Meeting of the Society, adjourned from May 1st, was continued in the Society's House, 5 Elizabeth-street North, at 8 p.m.

Mr. R. H. Cambage, President, in the Chair.

Twenty-one members and two visitors were present. Apologies were received from Professors David and Pollock, and Dr. Woolnough.

The minutes of the preceding meeting were read and confirmed.

A certificate duly signed by the office-bearers, on the state of the Society's House, in accordance with Rule 36, was read.

The following Financial Statement for the year ended 31st March, 1912, was presented by Dr. H. G. Chapman (Acting Honorary Treasurer), received, and adopted:—

GENERAL ACCOUNT.

Receipts.		£ s. d.	£ s. d.
To Balance on 1st April, 1911 ...			103 2 8
,, Cash in Hand 1st April			2 1 0
Subscriptions	One Guinea ...	49 7 0	
	,, ,, Arrears ...	2 2 0	
	Two Guineas ...	386 8 0	
	,, ,, Arrears ...	50 10 0	
	,, ,, In Advance ...	4 4 0	
			494 11 0
To Parliamentary Grant on Subscriptions received— Vote for 1911-1912 ...			400 0 0
,, Rent ...			461 11 6
,, Sundries...			65 8
,, Clarke Memorial Fund ...			22 0 0
			£1548 14 8

PAYMENTS.		£ s. d.
By Advertisements		11 1 9
,, Assistant Secretary		171 10 0
,, Assistant Librarian		100 1 0
,, Books and Periodicals		40 3 1
,, Bank Charges		0 10 0
,, Caretaker		78 0 0
,, Electric Light...		20 4 11
,, Engineering Association Compensation ...		10 0 0
,, Entertaining		6 11 0
,, Freight, Charges, Packing, etc.		13 8 3
,, Gas		5 12 0
,, Insurance		19 15 5
,, Interest on Mortgage		124 0 0
,, Office Expenses and Sundries		10 12 11
,, Office Boy		27 0 0
,, Printing		43 15 9
,, Printing and Publishing Journal		208 8 3
,, Rates		63 12 6
,, Repairs		27 1 3
,, Lanternist		22 1 10
,, Stamps		39 12 6
,, Stationery		11 15 6
,, Miscellaneous Expenses		25 8 8
,, Clarke Memorial Fund—Repaid Loan General Account Interest		22 4 4
,, Repaid on Account Loan to Building and Investment Fund	18 15 11	
Interest	0 13 2	
	19 9 1	
Less amount due to General Fund from Clarke Memorial Fund	2 3 6	
		17 5 7
,, Cash in Bank		99 10 7
,, Cash in hand		20 19 0
,, Deficiency ascertained to date		308 8 7
		£1548 14 8

BUILDING AND INVESTMENT FUND.

Dr.	£ s. d.
To Loan on Mortgage at 4%	3100 0 0
,, Clarke Memorial Fund—Loan 31st March, 1911... ...	18 15 11
	£3118 15 11

Cr.	£	s.	d.
By Deposit in Government Savings Bank, March 31st, 1912	1	8	2
„ Loan Repaid to General Account	18	15	11
„ Balance of Account, 31st March, 1912	3098	11	10
	£3118	15	11

CLARKE MEMORIAL FUND.

Dr.	£	s.	d.
To Amount of Fund, 31st March, 1911	516	2	8
„ Interest to 31st March, 1912	16	9	3
„ General Account Repaid on a/c Loan	22	0	0
„ Repaid on a/c of Building and Investment Fund... ...	18	15	11
„ General Account, Balance, 31st March, 1911	2	3	6
	£575	11	4

Cr.	£	s.	d.
By Loan to General Fund...	22	0	0
„ Loan to Building and Investment Fund, 31st March, 1911	18	15	11
„ Repaid to General Fund	2	3	6
„ Balance—			
Deposited in Savings Bank of N. S. W., March 31, 1912	311	14	2
Government Savings Bank, March 31, 1912	220	17	9
	£575	11	4

Compiled from the books and accounts of the Royal Society of New South Wales and certified to be in accordance therewith.

W. PERCIVAL MINELL, *Auditor.*
HENRY G. CHAPMAN, *Acting Honorary Treasurer.*

SYDNEY, MAY 23RD, 1912

The adjourned Annual Meeting then resolved itself into the General Monthly Meeting, being the three hundred and forty-ninth (349th) General Meeting of the Society.

The certificates of candidates for admission as ordinary members were read; one for the second, and four for the first time.

His Honour Judge DOCKER and Mr. W. S. DUN were appointed Scrutineers, and Mr. H. G. SMITH deputed to preside at the Ballot Box.

The following gentleman was duly elected an ordinary member of the Society:—

H. J. MELDRUM, Science Master, Fort-st. High School.

THE FOLLOWING PAPERS WERE READ:

1. "A new Mineral," by A. J. ULLMANN. Read by Mr. MAIDEN in the absence of the author.

Some remarks were made by Dr. ANDERSON.

2. "Some observations on the bio-chemical characteristics of bacilli of the Gaertner-Paratyphoid-Hog Cholera Group," by BURTON BRADLEY, M.B., Ch.M., M.R.C.S.

Drs. CHAPMAN and GREIG-SMITH and Mr. MAIDEN took part in the discussion.

Dr. J. B. CLELAND then delivered a Lecturette entitled:—
"Injuries and diseases to man in Australia attributable to animals (except insects)."

Remarks were made by Dr. QUAIFE, Mr. W. J. CLUNIES ROSS, and His Honor Judge DOCKER.

ABSTRACT OF PROCEEDINGS, JULY 3rd, 1912.

The three hundred and fiftieth (350th) General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth-street North, at 8 p.m.

Mr. R. H. CAMBAGE, President, in the Chair.

Twenty-one members were present.

The minutes of the Adjourned Annual Meeting of the 5th June, and of the General Monthly Meeting were read and confirmed.

The certificates of candidates for admission as ordinary members were read; four for the second, and one for the first time.

Dr. H. I. JENSEN and Dr. C. ANDERSON were appointed Scrutineers, and Dr. QUAIFE deputed to preside at the Ballot Box.

The following gentlemen were duly elected as ordinary members of the Society:—

L. A. Curtis, L.S., Union-street, Mosman.

R. H. Grieve, B.A., Llandaff-street, Waverley.

E. MacKinnon, B.Sc., Bureau of Microbiology, Sydney.

B. J. Smart, B.Sc., Public Works Office, Lithgow.

The President made the following announcements :—

1. That the Popular Science Lecture on "Shifts for a living in the Plant World," by Mr. G. P. Darnell-Smith, B.Sc., would be delivered in the Society's House on July 18th, 1912.

2. That an exhibition of the Federal Capital designs would be held in Sydney, and he invited members to inspect them.

THE FOLLOWING PAPERS WERE READ:

1. "On a new *Prostanthera* and its Essential Oil," by R. T. Baker, F.L.S., and H. G. Smith, F.C.S.

The President, and Mr. Maiden took part in the discussion.

2. "The Differential Phenomena of the Prospect Intrusion," by H. Stanley Jevons, M.A., B.Sc., H. I. Jensen, D.Sc., and C. A. Sussmilch, F.G.S.

Remarks were made by Mr. E. C. Andrews and the President, and the latter took the opportunity of offering the congratulations of the Society to Dr. Jensen on his appointment as Government Geologist of the Northern Territory.

EXHIBITS:

Mr. Maiden exhibited some specimens to illustrate a paper read by Mr. Edward Palmer (afterwards M.L.A. of Queensland), on plants used for various purposes by the aborigines of the Gulf of Carpentaria, before this Society on 1st August, 1883. The specimens had been presented to the National Herbarium, Sydney, by Mr. Palmer's widow.

ABSTRACT OF PROCEEDINGS, AUGUST 7th, 1912.

The three hundred and fifty-first (351st) General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth-street North, at 8 p.m.

Mr. R. H. Cambage, President, in the Chair.

Twenty-six members were present.

The minutes of the preceding meeting were read and confirmed.

The certificate of a candidate for admission as an ordinary member was read for the second time.

Mr. W. J. Clunies Ross and Mr. C. A. Sussmilch were appointed Scrutineers, and Mr. W. M. Hamlet deputed to preside at the Ballot Box.

The following gentleman was duly elected an ordinary member of the Society :—

Sidney Radcliff, Radium Hill Works, Woolwich.

Dr. T. Harvey Johnston, The University, Brisbane, having been nominated by the Council as a Corresponding Member, was, after a ballot, declared to be duly elected.

The President made the following announcements :—

1. That at the meeting of 4th September the question of popularising Forestry in Australia would be discussed.

2. That a Popular Science Lecture, on "The wonders of the Soil," would be delivered by Professor R. D. Watt, M.A., B.Sc., in the Society's Hall, on the 15th August, 1912.

3. That the Geological Section would meet on the 14th August, 1912.

4. That donations consisting of 12 volumes, 227 parts, 6 reports, 9 pamphlets, and 6 maps had been laid upon the table.

THE FOLLOWING PAPERS WERE READ:

1. "Notes on a Model of New England and the Associated Topographical Forms," by E. C. ANDREWS, B.A., read in abstract by Mr. C. A. SUSSMILCH, by whom also the model was exhibited.

2. "Notes on Two Lightning Flashes near Sydney," by Dr. F. H. QUAIFE, M.A.

EXHIBITS:

Mr. R. T. BAKER exhibited models of the Cullinan Diamond and the stones cut therefrom.

Mr. C. A. SUSSMILCH exhibited apparatus used in determining precious stones.

Mr. R. H. CAMBAGE exhibited specimens recently collected by him of Carboniferous fossils known as *Rhacopteris* from Currabubula near Tamworth, which are of interest in extending the known range of this type from the Stroud-Clarence Town district.

Mr. J. H. MAIDEN exhibited the following botanical specimens collected by Mr. SIDNEY W. JACKSON, Ornithologist:—

Two specimens of young bark of the large Queensland Kauri Pine, *Agathis Palmerstoni*, F.v.M., Tinaroo Scrubs, Upper Barron River, North Queensland. One is a dancing figure of a male native, 12½ inches in greatest length and breadth. The other is roughly in the form of a cross and denotes a female native. The blacks originally cut figures of these shapes through the bark, which they removed. The young bark closes over the wounds, forming objects like those shown.

The following specimens were obtained from the Collarenebri District:—

Portions of the stems of the Eurah Tree, *Eremophila bignoniflora*, F.v.M., which were once used by

the natives for making fire by friction, the inflammable material round the hole of the horizontal stick being dry kangaroo dung.

Specimens of Budda or Budtha, *Eremophila Mitchelli*, Benth., green logs of which were used in the early days for obtaining tar for branding by a rough process of dry distillation.

Fruits of *Pittosporum phillyrœoides*, DC., Butter Bush, from the play-grounds of the Spotted Bower Bird. It will be observed that the birds have only selected those fruits which are markedly heart-shaped, and which have not dehisced.

Specimens of the Nypang, *Capparis lasiantha*, R.Br., in flower and showing the recurved hooks which are particularly abundant on the young stems, and which enable the plant to scramble up trees and shrubs.

Fruits etc. of the allied *Capparis Mitchelli*, Lindl., sometimes called the Native Orange.

Fragments of the scale bark of the Carbeen, *Eucalyptus tesselaris*, F.v.M., which forms tesseræ, roughly in one inch cubes, and from which the specific name *tesselaris* is derived.

The various specimens were accompanied by herbarium specimens.

ABSTRACT OF PROCEEDINGS, SEPTEMBER 4th, 1912.

The three hundred and fifty-second (352nd) General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth-street North, at 8 p.m.

Mr. R. H. Cambage, President, in the Chair.

Twenty-three members and eighteen visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of candidates for admission as ordinary members were read; three for the second, and one for the first time.

Dr. C. ANDERSON and Mr. C. A. SUSSMILCH were appointed Scrutineers, and Mr. H. G. SMITH deputed to preside at the Ballot Box.

The following gentlemen were duly elected as ordinary members of the Society:—

Dr. FREDERICK GUY GRIFFITHS, B.A., 135 Macquarie-street, Sydney.

E. H. FULCHER SWAIN, District Forester, Forest Department, Narrabri.

E. F. HALLMANN, B.Sc., 65 View-street, Annandale.

The President made the following announcements:—

1. That a Popular Science Lecture, entitled "Pre-historic Man," by Dr. S. A. SMITH, would be delivered in the Society's Hall, on September 19th, 1912.

2. That donations consisting of 5 volumes, 92 parts, 8 reports, 7 pamphlets and 4 maps had been laid upon the table.

THE FOLLOWING PAPER WAS READ:

"Note on Some Recent Marine Erosion at Bondi," by Mr. C. A. SUSSMILCH, F.G.S.

At the request of the Forest Department, the Council decided to invite members and friends to consider the question of popularising Forestry in New South Wales, and an informal discussion took place.

The President made some opening remarks and then invited Mr. MAIDEN to introduce the subject.

Mr. R. D. HAY (Director of Forests) gave an account of the work of the Interstate Conference on Forestry at which

the subject was first brought up, and also of the American Forestry Association.

Mr. R. T. Baker spoke of the value of the Eucalyptus Oil industry.

Dr. Farnsworth spoke of the scarcity of timber in South Africa.

Mr. J. Breckenridge spoke of the scarcity of timber in New South Wales, and also the approaching famine in Oregon timber.

Mr. White emphasised the remarks of the previous speaker.

Mr. R. Mc. C. Anderson urged the Minister for Agriculture and other politicians to take the matter up.

Mr. J. M. Pringle spoke of his travels in the Pine forests of Gascony, and, as a builder, alluded to the increasing scarcity of timber.

Dr. J. B. Cleland suggested an informal meeting of members of the Society with the view of helping in the inauguration of a Forestry League.

Mr. J. Langley asked the Society to pass a resolution in favour of the formation of a League.

Mr. McKell suggested that the constitution of the "Millions Club" covered the objects of such a League, and indicated that the Club would help.

The President gave statistics in regard to the land set apart for forests in New South Wales, and advocated the study of the introduction of useful exotic trees, and the advancement of forestry education.

On the motion of Dr. Cleland, seconded by Mr. Baker, the following resolution was carried unanimously:—

> "That this Society considers that the formation of a Forestry League in New South Wales is desirable."

On the motion of Mr. HAY, the visitors passed a hearty vote of thanks to the Society for permitting the discussion.

EXHIBITS.

1. By the Rev. E. F. PIGOT, S.J., Riverview College Observatory. The exhibit shews the exact copy, to scale, of a portion of the record of the recent Dardanelles earthquake on August 9th. The large waves seen are those of the third phase, at the time of Sydney's maximum movement. The largest wave here shewn had a complete period of 18 seconds, and $\frac{1}{40}$th of the amplitude on the seismograph record, viz. 0·162 of a millimetre, was the maximum displacement from zero position of the earth-particles. This wave reached Riverview at 12h. 52m. 55s. p.m., Sydney standard time, about an hour and a quarter after the shock itself. The earliest wave of the first phase of course arrived much sooner, at 11h. 50·0m. a.m., or 14 minutes after the catastrophe.

2. By Mr. J. H. MAIDEN. Volume I of two folio volumes of original contemporary water colour drawings by John William Lewin (1770–1819) of Sydney, of plants collected by Allan Cunningham in various parts of New South Wales, in 1817 and 1818. The writing in pencil is by Allan Cunningham himself.

The volumes, which are of considerable value, were presented to the Botanic Gardens by Lady W. PHIPSON BEALE of London, a native of Sydney, through the kind intermediation of Professor LIVERSIDGE.

ABSTRACT OF PROCEEDINGS, OCTOBER 2nd, 1912.

The three hundred and fifty-third (353rd) General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth-street North at 8 p.m.

Mr. R. H. CAMBAGE, President, in the Chair.

Thirty-one members and four visitors were present.

The minutes of the preceding meeting were read and confirmed.

Two new members, Mr. R. H. GRIEVE and Dr. F. G. GRIFFITHS, enrolled their names and were introduced.

The certificate of candidates for admission as ordinary members were read; one for the second, and two for the first time.

Mr. J. C. CARNE and Dr. C. ANDERSON were appointed Scrutineers, and Mr. H. G. SMITH deputed to preside at the Ballot Box.

The following gentleman was duly elected an ordinary member of the Society:—

HENRY TASMAN LOVELL, M.A., Ph.D., Hodson Avenue, Cremorne.

The President made the following announcements:—

1. That a Popular Science Lecture entitled "Drought-resisting Plants," by Mr. A. G. HAMILTON, would be delivered in the Society's Hall, on October 17th, 1912.

2. That a meeting of the Geological Section would be held on the 9th instant.

3. That donations consisting of 1 volume, 129 parts, 10 reports, 2 pamphlets and 5 maps, had been laid upon the table.

THE FOLLOWING PAPER WAS READ:

"Beach Formations at Botany Bay," by E. C. ANDREWS, B.A.

Mr. BROOME P. SMITH, late of West Africa, then gave a brief lecturette, illustrated by lantern slides, on some of his observations in Tropical Africa—Ethnological, topographical, etc.

On the motion of Professor DAVID, a hearty vote of thanks was given to the lecturer.

ABSTRACT OF PROCEEDINGS, NOVEMBER 6th, 1912.

The three hundred and fifty-fourth (354th) General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth-street North, at 8 p.m.

Mr. R. H. CAMBAGE, President, in the Chair.

Forty-four members and four visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of candidates for admission as ordinary members were read; two for the second, and one for the first time.

Dr. COOKSEY and Mr. HALLIGAN were appointed Scrutineers, and Dr. WOOLNOUGH deputed to preside at the Ballot Box.

The following gentlemen were duly elected as ordinary members of the Society:—

ARTHUR JOHN HARE, Under Secretary for Lands, Monte Christo-street, Woolwich.

Dr. HERBERT JERMYN FARNSWORTH, Bannerman-street, Neutral Bay.

Seven volumes, 174 parts, 20 reports, 3 catalogues, and 1 map, were laid upon the table.

THE FOLLOWING PAPER WAS READ:

"On the Crystalline Deposit occurring in the Timber of the Colonial Beech *(Gmelina Leichhardtii)* by HENRY G. SMITH, F.C.S.

The paper was discussed by Mr. BERTRAM J. SMART and Dr. COOKSEY. Mr. SMITH replied.

A lecturette (with lantern slides) on "A recent visit to New Guinea," by J. E. CARNE, F.G.S., was then given.

By invitation of the President, Professor J. MACMILLAN BROWN, of Christchurch, New Zealand, who had travelled much in the Malay Archipelago and New Guinea, addressed the meeting on the ethnology of the natives of the islands.

Votes of thanks to Mr. CARNE and Professor BROWN were cordially tendered.

Mr. R. H. MATHEWS, L.S., then exhibited the method of lighting a fire by flint and steel. In the box he used the fungus of a species of *Polyporus* as tinder, as bushmen used to do, and also Stringybark for the fire.

Mr. W. M. HAMLET also brought a tinder box and made a demonstration to supplement that of Mr. MATHEWS.

Mr. HAMLET exhibited an Immisch thermometer.

ABSTRACT OF PROCEEDINGS, DECEMBER 4th, 1912.

The three hundred and fifty-fifth (355th) General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth-street North, at 8 p.m.

Mr. R. H. CAMBAGE, President, in the Chair.

Thirty-four members and three visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificate of one candidate for admission as an ordinary member was read for the second time.

Mr. R. T. BAKER and Mr. W. J. CLUNIES ROSS were appointed Scrutineers, and Mr. F. B. GUTHRIE deputed to preside at the Ballot Box.

The following gentleman was duly elected an ordinary member of the Society:—

ALEX. GREENLAW HAMILTON, Lecturer on Nature Study, Teachers' College, Blackfriars.

Fourteen volumes, 228 parts, 16 reports, and 4 maps were laid upon the table.

THE FOLLOWING PAPERS WERE READ:

1. "Some Crystal measurements of Chillagite," by Miss C. D. SMITH, B.Sc., and LEO A. COTTON, B.A., B.Sc.

The paper was read by Mr. COTTON, and Dr. WOOLNOUGH offered some observations.

The crystals examined were presented to the Sydney University by Mr. ULLMANN, of the Christmas Gift Mine, Chillagoe. Analyses by the Queensland Department of Mines show the presence of lead, molybdenum and tungsten. The crystals are therefore related to both stolzite and wulfenite. Crystal measurements show distinct differences from both of these minerals. The result of these measurements and the evidence of the analyses suggest that the crystals may belong to a new mineral species. This cannot however be certainly established on the present data. The name Chillagite has been adopted to distinguish the new crystal combination.

2. "The occurrence of the genus *Spirangium* in the Hawkesbury Series," by W. S. DUN.

Mr. W. S. DUN read a preliminary note on the discovery of *Spirangium* in the Wianamatta Shales at Brookvale, near Manly.

Spirangium is a fossil, the interpretation of which is a vexed question. It is usually regarded as the fructification of some plant, and consists of a stalked elongated cone, formed of tetragonal scales arranged spirally and terminating in a long spine. It has been regarded as the egg of

a shark, or else a coprolite, but it is usually considered to be of vegetable origin. Remarks were made by Professor David.

3. "On two new Grass Smuts," by Ewen MacKinnon, B.Sc.

Remarks were made by Mr. Maiden.

EXHIBITS:

1. A hydrous aluminium phosphate from Reservoir Hill, Murwillumbah, by Professor David. It is abundant, and the impure mineral is used for road making.

2. Experiments with colloidal solutions or silicic acid gels, by Mr. W. J. Clunies Ross. These exhibits illustrate the various ways in which gels of silicic acid may be obtained from water glass, silicate of soda, by means of hydrochloric acid:

First, coloured gels. Crystals of salts are dropped into a solution of water glass, and allowed to grow. The solution is then partly poured off, and HCl added. With dilute HCl an opaque gel is formed. With excess of concentrated HCl a clear gel, the growth becoming white and the gel coloured, if from coloured salts.

Second, solution of water glass taken, chloride of gold added. Then the solution converted to gel by hydrochloric acid. Solutions of various reducing agents poured on to gel. Result shewn, after about a fortnight.

Remarks were made by Mr. Hamlet.

3. Miscellaneous botanical exhibits, by Mr. J. H. Maiden.

(*a*) White Pine fruits (*Callitris robusta*) from the Gunnedah district, which had been attacked by green leek parrots for their seeds, and thus a scarcity of seedlings had been caused.

(*b*) Fruits and flowers of *Grewia polygama* from Papua, received from the Papuan Government as a remedy in dysentery.

(*c*) Leaves of *Eucalyptus alba* from Mackay, Queensland, up to 12 × 11 inches, dry.

(*d*) Branches of *Daphnandra micrantha* called Socket Wood, because of the marked articulation of the branches to the stem.

(*e*) Copy of the recently passed West Australian Act for the Protection of Native Flora.

4. Dr. J. B. CLELAND drew attention to the recent dedication of a window in memory of Captain Cook in the Church of S. Cuthbert, Marton-in-Cleveland, Yorkshire, England.

ABSTRACT OF PROCEEDINGS

OF THE

GEOLOGICAL SECTION.

Monthly Meeting, 10th April, 1912.

Mr. R. H. CAMBAGE in the Chair.

Six members were present.

On the motion of Mr. W. S. DUN, seconded by Dr. WOOLNOUGH, Prof. T. W. E. DAVID was elected Chairman, and on the motion of Mr. E. C. ANDREWS, seconded by Dr. WOOLNOUGH, Mr. C. A. SUSSMILCH was re-elected Secretary for the ensuing year.

A motion was carried congratulating Mr. T. G. TAYLOR, B.A., B.Sc., on his safe return from Antarctica.

Mr. C. A. SUSSMILCH then gave an account of his recent visit to America.

Monthly Meeting, 8th May, 1912.

Prof. T. W. E. DAVID in the Chair.

Nine members and four visitors were present.

The chairman formally welcomed Mr. A. GIBB MAITLAND (Government Geologist of Western Australia), and Mr. L. K. WARD (Government Geologist of South Australia) to the meeting.

Mr. C. A. SUSSMILCH exhibited specimens of Ferberite from Tungsten, Nevada, U.S.A., and specimens of Stolzite and Wulfenite from Broken Hill, N.S.W.

A discussion took place on the correlation of the Permo-Carboniferous formations of Australia in which Messrs.

A. Gibb Maitland, L. K. Ward, Prof. David, W. S. Dun, Dr. Woolnough, E. C. Andrews, A. B. Walkom and C. A. Sussmilch took part. While no definite conclusions were arrived at, much useful information was presented and valuable suggestions were made as to the lines upon which further investigations should be made.

Monthly Meeting, 5th June, 1912.

Prof. T. W. E. David in the Chair.

Ten members present and eight visitors.

The chairman, on behalf of the members, congratulated Dr. H. I. Jensen on his appointment as Federal Geologist to the Northern Territory, and wished him every success in his new position.

Professor David gave a detailed account of the geological results of the Shackleton Antarctic Expedition. The address, which summarised the present knowledge of the geology of Antarctica, was illustrated by geological sections and many specimens. Some remarks on the petrology of this region were made by Dr. W. G. Woolnough.

Monthly Meeting, 9th October, 1912.

Prof. T. W. E. David in the Chair.

Eight members were present.

Dr. C. Anderson exhibited a new meteorite from Binda near Goulburn.

Dr. W. G. Woolnough exhibited a number of rock specimens from Perth, W.A., illustrating a succession of igneous intrusions in the one quarry.

The chairman, on behalf of the members, congratulated Mr. J. E. Carne on his safe return from his New Guinea Expedition.

Mr. J. E. CARNE then gave an account of the geological results of his New Guinea expedition with particular reference to the probable occurrence of coal and oil in that country.

Monthly Meeting, 13th November, 1912.

Prof. T. W. E. DAVID in the Chair.

Five members were present.

Mr. R. H. CAMBAGE exhibited a specimem of *Rhacopteris inequilatera* and some igneous rocks from Currabubula, New England, N.S.W., and some photographs of the locality.

A discussion took place on Messrs. JEVONS, TAYLOR, JENSEN and SUSSMILCH'S paper on the geology and petrology of the Prospect intrusion.

Monthly Meeting, 11th December, 1912.

Prof. T. W. E. DAVID in the Chair.

Six members were present.

Dr. C. ANDERSON exhibited specimens of a radio-active copper mineral from Moonta, South Australia.

Prof. DAVID gave a summary of some recent geological work by Messrs. DUNSTAN and RICHARDS in the Maryborough District, Queensland, as a result of which they have expressed the view that the Burrum formation is of younger geological age than the Rolling Downs formation. A discussion followed on the general correlation of the Mesozoic Freshwater Beds of Eastern Australia.

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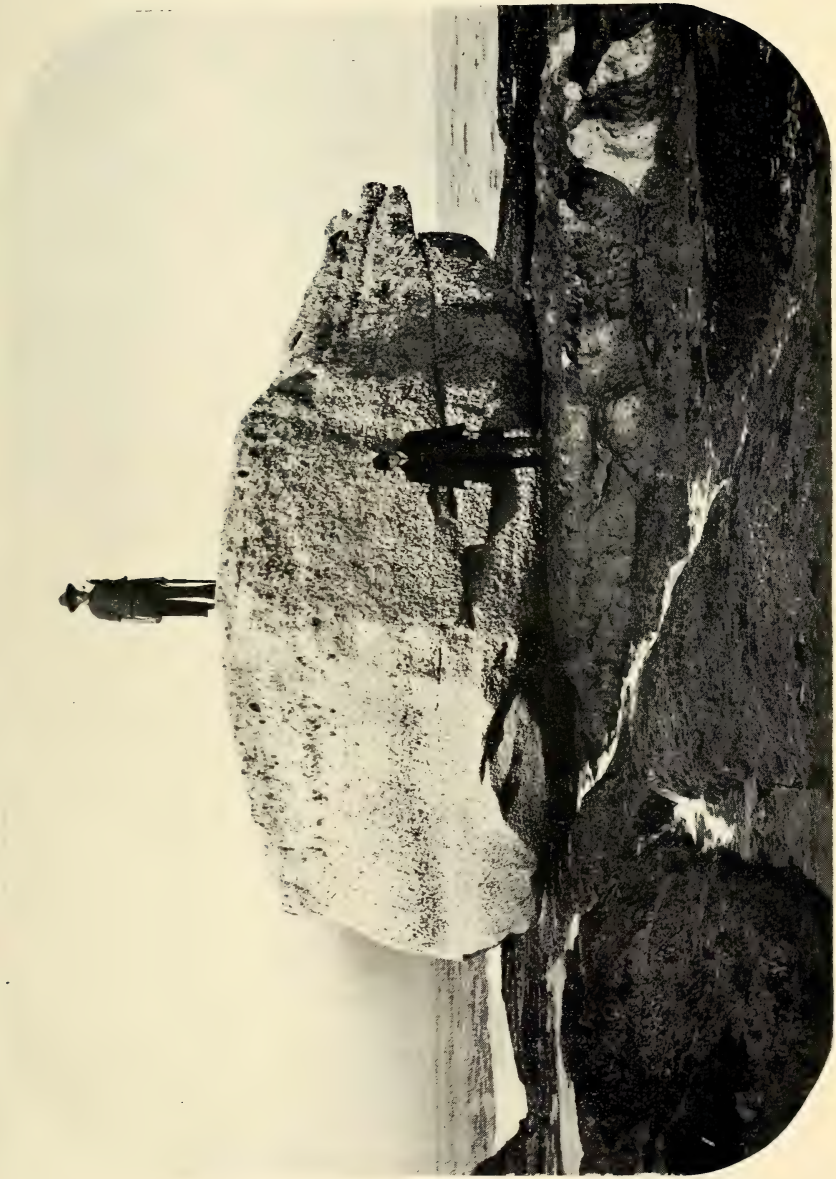
R.T.B. del.

PROSTANTHERA CINEOLIFERA, Sp., Nov.

Photograph of part of one of the large Segregation Veins.

Photograph of Model of New England District.



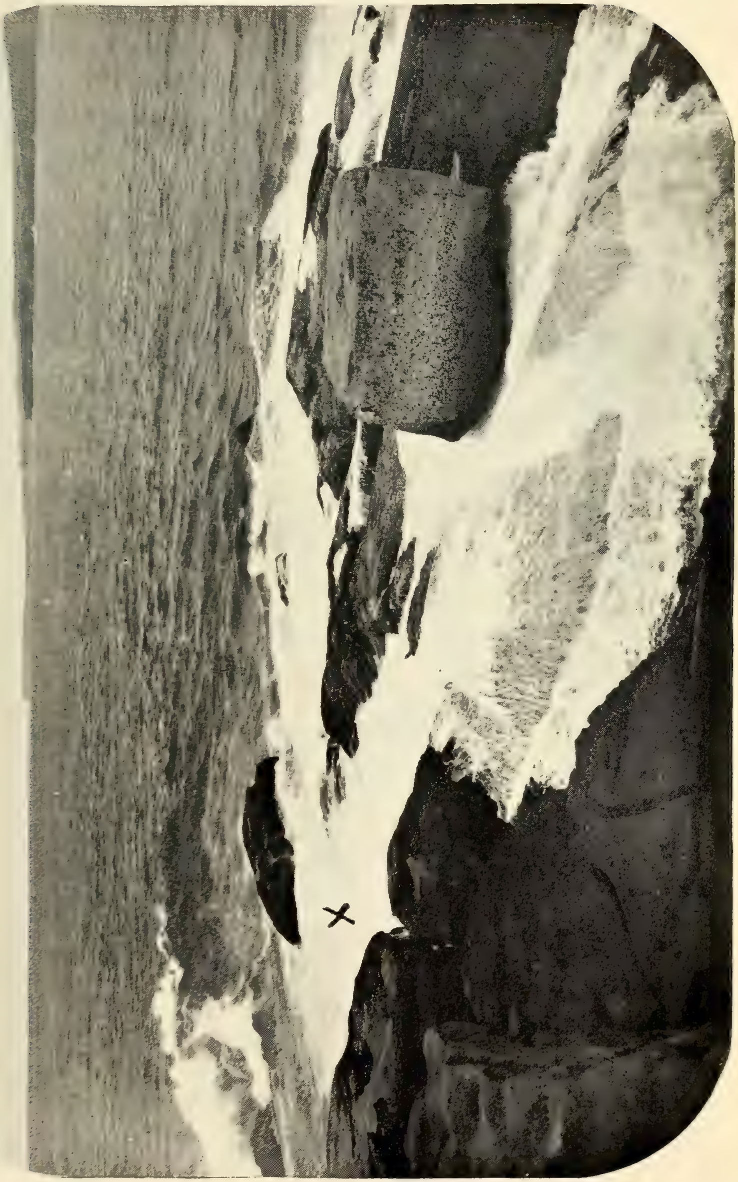
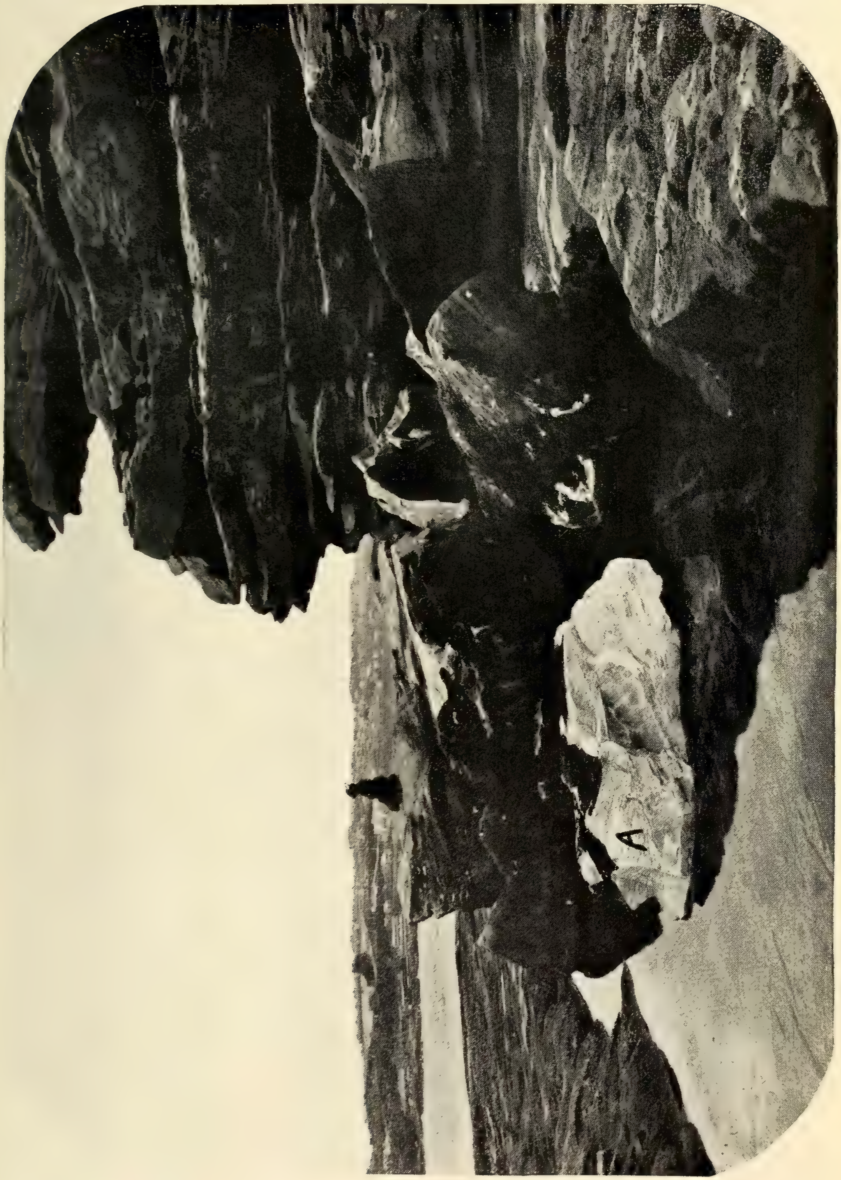


Plate VI.



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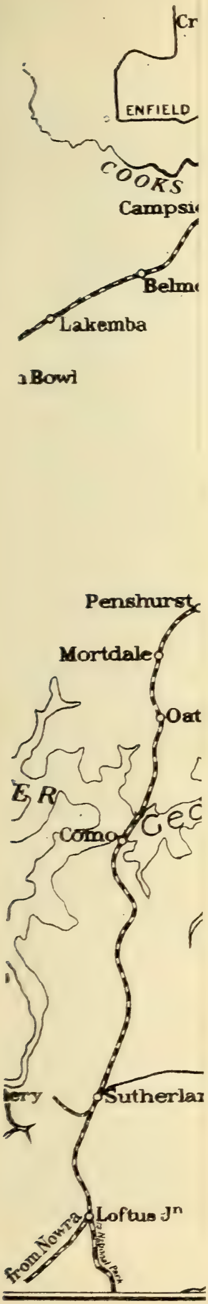
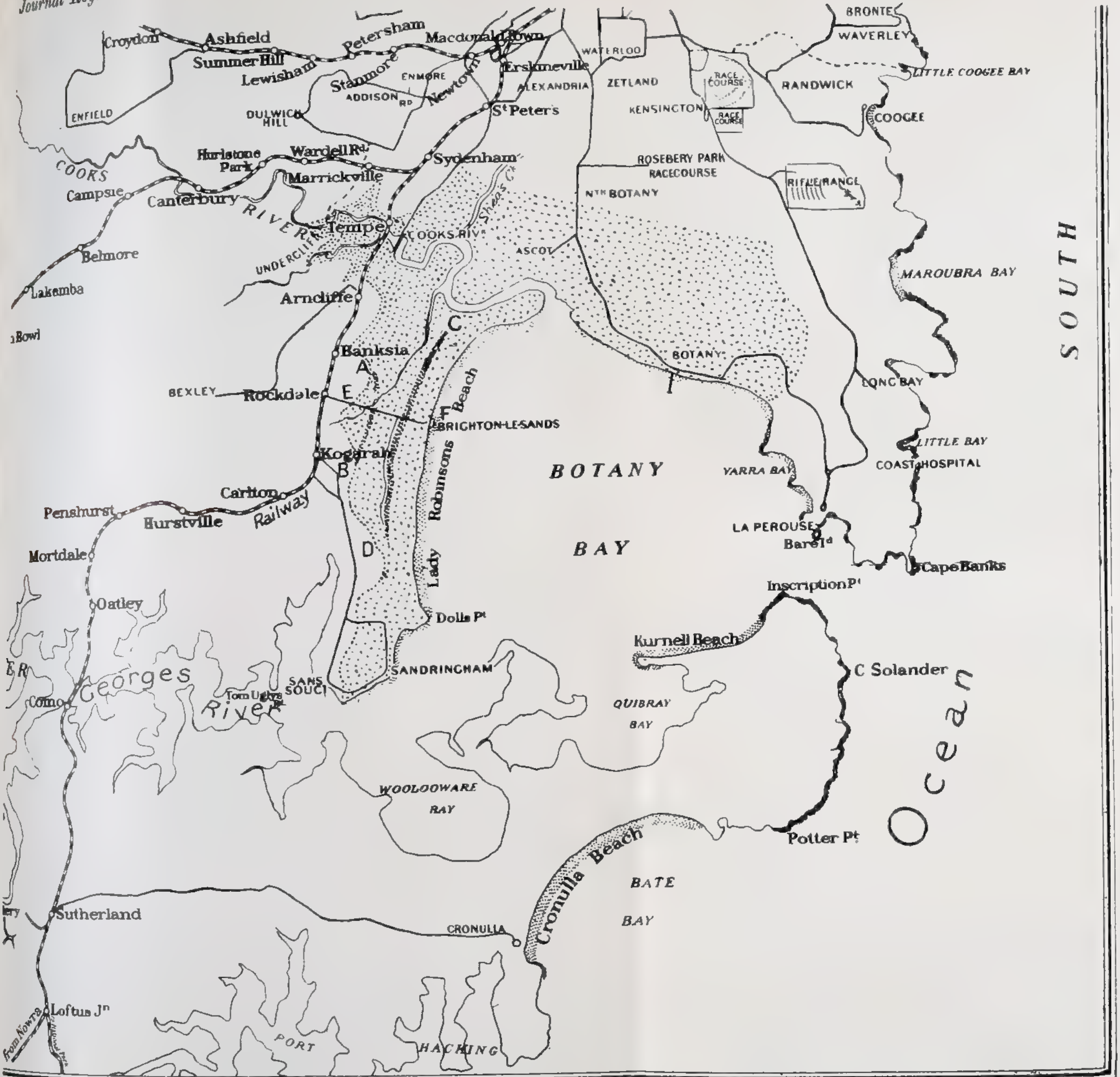


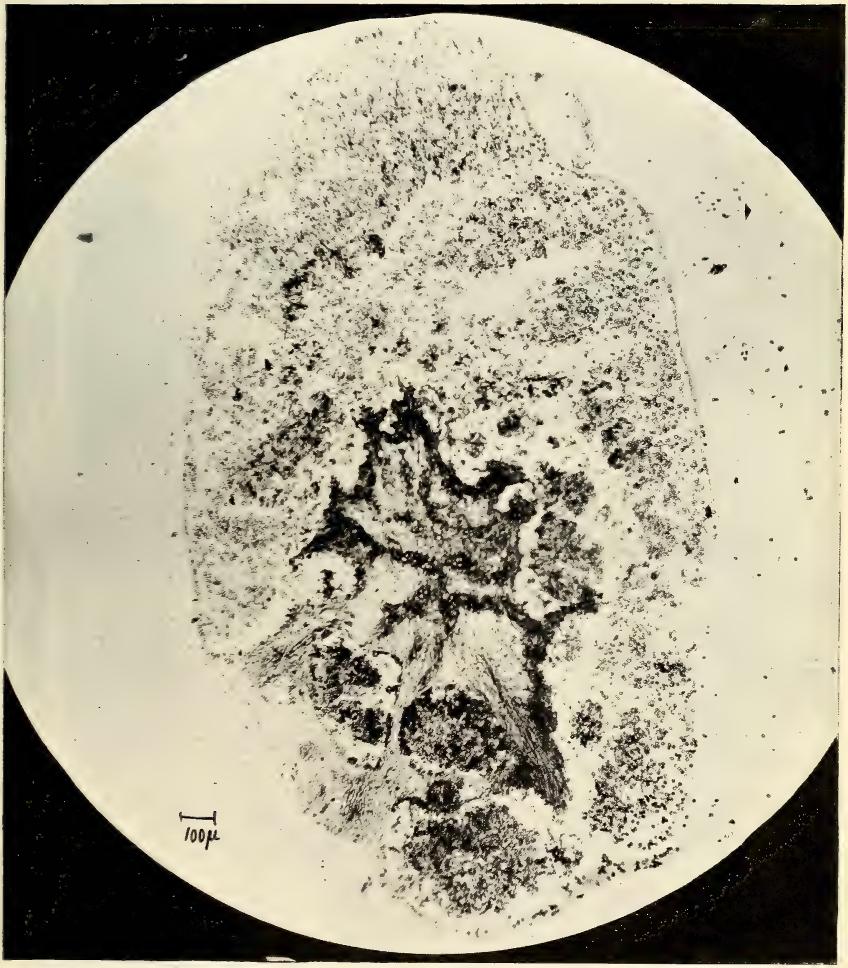


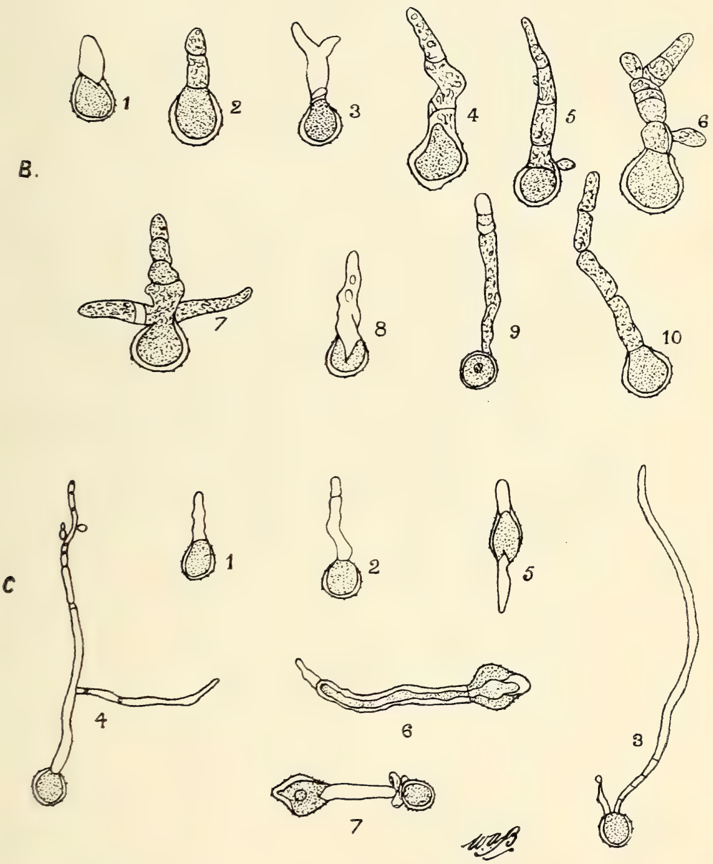
Map of Botany Bay. Scale two miles to an inch. Dotted area, alluvium and sand.

Crystalline deposit of gmelinol in the timber of GMELINA LEICHHARDTII.
Natural size.

Gmelinol from natural deposit in the timber of GMELINA LEICHHARDTII. *Crystallised from water. Magnified 35 times.*


G1
G3
G2
100 μ


100μ


B.
1
2
3
4
5
6
7
8
9
10
C
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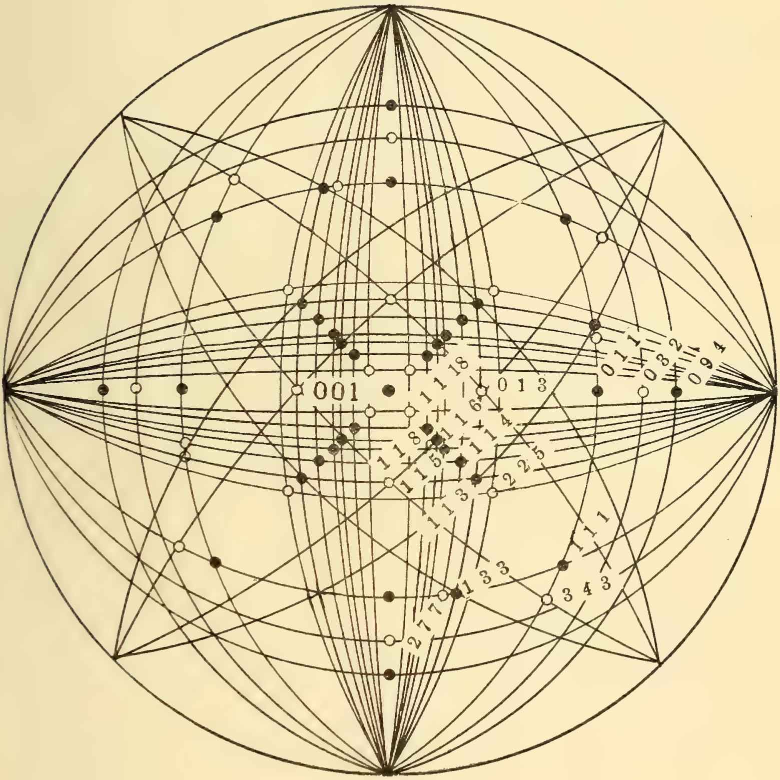
7


001
1 1 18
0 1 3
0 1 1
0 3 2
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1 1 4
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1 1 5
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1 3 3
3 4 3
2 7 7

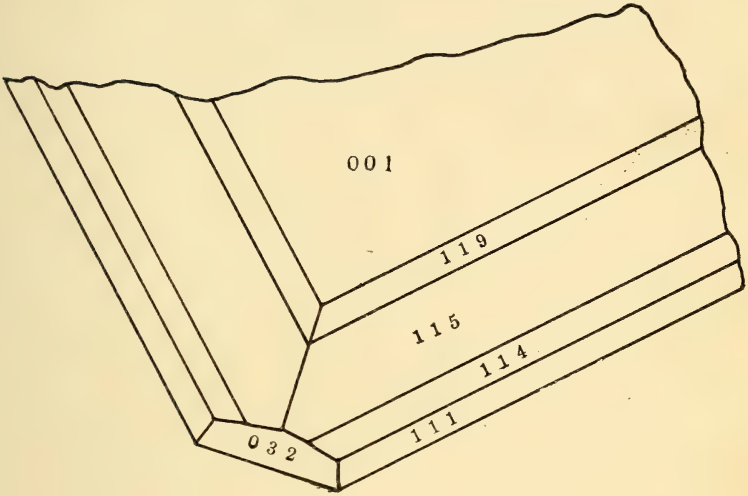

Fig. 1.

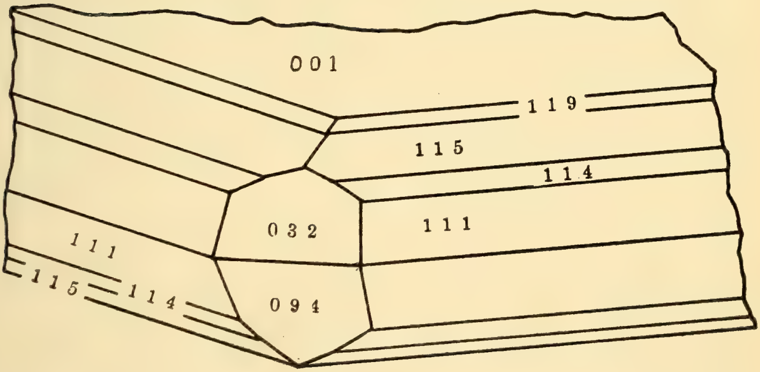

Fig. 2.

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